

AMERICAN TREE FARM SYSTEM®

LANDSCAPE MANAGEMENT PLAN

State of South Carolina



Landscape Management Plan Creation

Plan Development and Composition

The [American Forest Foundation \(AFF\)](#), in conjunction with [Southern Forestry Consultants, Inc.\(SFC\)](#), developed the original components, outlines, structure, and drafts of the Landscape Management Plan (LMP) and the associated geodatabase. AFF and SFC also worked cooperatively to evaluate and incorporate edits, comments, and modifications that resulted in the final LMP and geodatabase.

Natural Resource Professional Support Committee

AFF consulted regularly with staff from the South Carolina Forestry Commission (SCFC) to seek their input on various thematic, structural, and scientific components through multiple drafts of this LMP. Additionally, SCFC staff facilitated access to and procurement of publicly available geospatial data during the development of the geodatabase.

Additional Stakeholders

AFF also sought input from a variety of additional stakeholders with expertise in the natural resources, planning, certification, and regulatory disciplines. Like the Support Committee, these additional stakeholders did not necessarily endorse all components of the LMP, nor does AFF imply a consensus was reached. These additional stakeholders included:

- [American Forest Management](#)
- [Association of Consulting Foresters](#)
- [Audubon South Carolina](#)
- [Belle W. Baruch Foundation](#)
- [Bishop Brothers Forestry Consultants](#)
- [Boise Cascade Company](#)
- [Canfor Southern Pine](#)
- [Center for Heirs' Property Preservation](#)
- [Clemson Extension Service](#)
- [Congaree Land Trust](#)
- [Forestry Association of South Carolina](#)
- [Georgia Forestry Commission](#)
- [Georgia-Pacific Corporation](#)
- [Interfor Corporation](#)
- [International Paper Company](#)
- [Longleaf Alliance](#)
- [National Wild Turkey Federation](#)
- [Palmetto Conservation Foundation](#)
- [Pee Dee Land Trust](#)
- [Quality Deer Management Association](#)
- [SC Association of Conservation Districts](#)
- [SC Conservation Bank](#)
- [SC Department of Agriculture](#)
- [SC Department of Natural Resources \(DNR\)](#)
- [SC Native Plant Society](#)
- [SC Sustainable Forestry Initiative Implementation Committee](#)
- [SC State Park Service](#)
- [SC Timber Producers Association](#)
- [SC Tree Farm Committee](#)
- [SC Vegetation Management Association](#)
- [SC Wildlife Federation](#)
- [Sierra Club South Carolina](#)
- [The Nature Conservancy](#)
- [US Army – Fort Jackson](#)
- [US Fish & Wildlife Service](#)
- [USDA Farm Service Agency \(FSA\)](#)
- [USDA Forest Service](#)
- [USDA Natural Resources Conservation Service \(NRCS\)](#)
- [WestRock Company](#)
- [Weyerhaeuser Company](#)

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1 Introduction



1. INTRODUCTION

A landscape management plan (LMP) is a vital and innovative tool, offering a wide array of benefits and opportunities to landowners, foresters, and other natural resource professionals, state and federal agencies, conservation partners, and others. Specifically, this LMP can:

- Help family landowners overcome one of the biggest barriers to participating in forest certification and landowner assistance programs by eliminating the need for every landowner to develop and maintain an individual management plan.
- Support coordination of action on landscape-scale priorities across ownerships.
- Provide participating landowners with access to the benefits of the FSP and ATFS certification.
- Establish and strengthen relationships between landowners and their foresters.
- Be used by a diversity of forestry specialists, including SCFC Project Foresters, consulting foresters, and industrial foresters.
- Be implemented adaptively across an array of conditions, landowner objectives, and ownerships. Although arranged as a single document, the chapters are designed both to support each other and to be used flexibly as forest conditions and objectives change.
- Illustrate practical silvicultural options to manage family woodlands sustainably, achieve landscape conservation goals, and conform to AFF Standards of Sustainability through a variety of strategies and approaches for forest ecosystems specific to the South Carolina landscapes.
- Utilize the best available science and resources provided at the federal, state, and local levels through a program- developed and -maintained geospatial database.
- Support the efforts of foresters from across sectors to work with previously unengaged landowners and promote conservation initiatives.
- Optimize grant funding at the local, state, and national level for conservation initiatives on private land.
- Preemptively address threats to at-risk species through habitat protection.
- Provide additional access to certified materials for timber industry partners.

This LMP is designed to complement and align with federal, state, and local laws. Resources in this LMP do not override local forestry regulations that may not be addressed directly in this plan.

Forest management plans have long been a principal component of traditional family woodland owner programs in the United States. Management plans are a requirement for forest certification and landowner assistance programming and, because the individual plans are costly for both landowners and foresters to develop, they are often the biggest barrier to family landowner engagement. In addition, recent research suggests that the development of individual landowner forest management plans have only moderate to minimal impact on family woodland owner behavior. Rather, it is the accompanying engagement with or receiving technical advice from a natural resource management professional that provides the motivation and support landowners need to act on the ground. Even more, individual management plans do not offer a means for inspiring, understanding and coordinating important conservation strategies across family ownerships. By setting motivating goals at the landscape level we are creating another call to action that allows us to engage more landowners. We know that values like wildlife are important to landowners and this allows us to set aspirational goals for the landscape that line up with that motivation. The planning

process remains critical to sustainable forest management. However, there is a need for a more cost-effective approach that reflects what is known about what will effectively encourage family landowner behavior and support coordinated efforts to address the critical landscape-scale conservation needs and opportunities. Drawing on emerging research, models used in Scandinavia and techniques used by some American consulting firms, the landscape plan is designed to reduce the management plan barrier that family landowners face to becoming involved in conservation activities and streamline the American Tree Farm System® (ATFS) certification process. This approach maintains the credibility required for ATFS certification while providing landowners with the essential technical support to ensure their long-term sustainable management. Finally, it also offers a mechanism for coordinating landscape scale priorities across small and family owners.

The American Forest Foundation (AFF), in conjunction with numerous natural resource partners, has therefore developed this Landscape Management Plan (LMP) to address landowner and landscape-level objectives within the state of South Carolina. More specifically, this plan incorporates and supports all portions of the following site-specific and landscape level considerations that are applicable to family woodland landowners:

- AFF 2015-2020 Standards of Sustainability for Forest Certification (Standards)
- Forest Stewardship Program (FSP) National Standards and Guidelines (Standards)
- South Carolina Forest Stewardship Program
- South Carolina Forest Action Plan
- South Carolina State Wildlife Action Plan
- United States Department of Agriculture (USDA) National Woodland Owner Survey (NWOS) Results and Observations (Butler et al 2016)
- South Carolina Forestry Commission Best Management Practices
- National Register of Historic Places (NRHP) and the South Carolina Department of Archives and History (SCDAH)

This LMP will be revised and updated periodically to reflect changing dynamics with the specific forest resources and on the landscape broadly. Similarly, it is critical to monitor landowners' management to ensure congruence between the landscape management plan and continuity across the assemblage of landowners. This could be combined with routine monitoring, as required under certification, such as routine inspections.

1.1. Forest Resource Professionals

This LMP relies on the experience, skills, and thoughtful professionalism of foresters and other natural resource managers. The relationships they build with family woodland owners are central to the success of this LMP and to achieving the shared aims of delivering conservation impact.

As the [Society of American Foresters](#) (SAF) describes within the Preamble to its Code of Ethics:

“Service to society is the cornerstone of any profession. The profession of forestry serves society by fostering stewardship of the world’s forests. Because forests provide valuable resources and perform critical ecological functions, they are vital to the wellbeing of both society and the biosphere.” – [SAF Code of Ethics](#)

The role of forest resource professionals includes passing along their experience and expertise regarding the complex relationships between air, water, climate and weather, trees, flora and fauna, ecosystem processes, and anthropocentric considerations. This consultation and advice provided by forest resource professionals is commonly provided to landowners and/or their agents interested in managing their forestland. Landowners can utilize the services of a forest resource professional to manage and monitor vendors and contractors performing silvicultural management activities on the land. Forestry resource professionals also can assist landowners with contracts and the maintenance and retention of appropriate records and documentation relating to forest management activities and certification. Furthermore, landowners can gain advice regarding taxes, estate planning, and relevant laws, regulations, and ordinances under the guidance of a forest resource professional. This LMP was developed as a resource for these professional foresters to assist in landowner engagement, identification and characterization of landowner site specific features and objectives, and the identification and management of local forest types.

Various professional organizations and certification bodies, including state forester registration boards, [SAF](#), and the [Association of Consulting Foresters](#) (ACF), provide membership standards and requirements to ensure qualified, responsible, and ethical application of forestry principles is upheld. The ATFS also recognizes the importance of these forestry professionals by establishing specific [eligibility requirements and recertification standards](#) of all ATFS inspectors.

The [NRCS South Carolina Technical Service Provider Search Tool](#) is a listing provided to assist landowners in finding forest management related service providers for implementation of forestry practices on their land. This database includes forest management consultants, tree seedling nurseries, and other vendors and forest product buyers.

1.2. Adaptive Management

All silvicultural options, management activities, and implementation measures provided in this LMP are predicated upon a narrow window of site, weather, time, and market conditions. Changes and variability associated with these conditions (especially weather and markets) can have significant impacts on the timing, feasibility, and success of all silvicultural implementation operations. For example, the decision of when and how to harvest timber could vary tremendously based on recent weather conditions and market conditions. A recent example of this need for adaptive management occurred in Florida following the landfall of Hurricane Michael in 2018. An unprecedented storm for the panhandle of Florida, Michael damaged an

estimated 2.8 million acres of timber and caused 95% damage to 34,000 acres within Bay, Calhoun, and Gulf counties; these damages amounted to approximately \$1.289 billion dollars in losses (Etters 2019). As these types of events can devastate the local timber industry, landowners may need to restructure their assets and change their revenue source from their land. Following Michael in Florida, the University of Florida's Institute of Food and Agricultural Sciences (IFAS) assisted landowners in transitioning to different crop types to offset their timber losses. As South Carolina is squarely within the path of major Atlantic hurricanes and has the potential for future similar levels of devastation, it is important for landowners to know how to manage their land in the event of such a disaster.

Likewise, forest landowner objectives could significantly impact both the target forest type and the silvicultural implementation methods needed to meet those goals and objectives. Inherently, silvicultural operations have some flexibility on the timing of implementation to more effectively meet the narrow window of conditions to achieve the desired result. Harvesting operations and regeneration efforts are also variable and could vary significantly when focused on meeting different landowner's objectives like maximizing revenue or conserving rare species. The tolerance to shift operations slightly increases the feasibility of meeting the established goals and objectives. Therefore, this management plan should not be viewed as an unchangeable text, but rather a living document dependent on its constant evaluation, refinement, and modification for success.

1.3. 2015-2020 ATFS Standards of Sustainability within the LMP

The AFF's Standards promote the health and sustainability of America's family forests. These Standards are designed as a tool to help woodland owners be effective stewards of the land as they adaptively manage renewable resources; promote environmental, economic and social benefits; and work to increase public understanding of sustainable forestry. The Standards are based on international sustainability metrics and North American guidelines for sustainable forest management and serve as the basis for the ATFS certification program. The ATFS certification program is internationally endorsed by the Programme for the Endorsement of Forest Certification (PEFC™). Landowners following these Standards are recognized as ambassadors for exemplary woodland stewardship.

Each of the eight Standards of Sustainability addresses aspects of sustainable forest management. Moving from general to specific, each Standard incorporates performance measures and indicators to illustrate conformance. All components of each Standard apply to every property certified under the ATFS Standards. A standard is an overarching principle of sustainability. A performance measure refines the Standard's intent and describes considerations and pathways for conformance. An indicator identifies specific actions or activities that demonstrate conformance.

These standards, Performance Measures and indicators are presented below with links to the specific section of the LMP where they are addressed.

STANDARD ① Commitment to Practicing Sustainable Forestry

Performance Measure 1.1 Landowner shall have and implement a written forest management plan consistent with the size of the forest and the scale and intensity of the forest activities.

- **Indicator 1.1.1** Management plan shall be active, adaptive and embody the landowner's current objectives, remain appropriate for the land certified and reflect the current state of knowledge about natural resources and sustainable forest management.
- **Indicator 1.1.2 (a)** Management plans shall describe forest types, aesthetics, management activities aimed at achieving landowner's objectives, document a feasible strategy for activity implementation and include a map accurately depicting significant forest-related resources.
- **Indicator 1.1.2 (b)** The forest management plan shall demonstrate consideration of the following resource elements: forest health, soil, water, wood and fiber production, threatened or endangered species, special sites, invasive species, and forests of recognized importance. Where present and relevant to the property, the plan shall describe management activities related to these resource elements.
- **Indicator 1.1.2 (c)** Where present, relevant to the property and consistent with landowner's objectives, the plan preparer should consider, describe and evaluate the following resource elements: fire, wetlands, desired species, recreation, forest aesthetics, biomass and carbon.
- **Indicator 1.1.3** The landowner should monitor for changes that could interfere with the management objectives as stated in the management plan. When problems are found, reasonable actions are taken.

How the LMP Covers this Section:

- This LMP serves as the written management plan for all participating landowners in state of South Carolina. This plan provides the necessary flexibility to be active and adaptive to the variety of landowner objectives and related management activities available to the landowners in this state, regardless of the size and scale of their property. As noted in the links included throughout this section, this LMP addresses each of the ATFS Standards.
- A secure database was developed to include all the necessary spatial information to support sustainable forest management in the area. In addition to general information of the region (soils, hydrologic information, the presence or absence of T&E species, etc.), each landowner participating in this program can have specific information to their Tree Farm stored on this database by a forester or an ATFS Inspector. Maps can be generated from this database by a forester or ATFS Inspector, or upon request by the landowner or a third-party assessor.

STANDARD ② Compliance with Laws

Performance Measure 2.1 Landowner shall comply with all relevant federal, state, county and municipal laws, regulations and ordinances governing forest management activities.

- **Indicator 2.1.1** Landowner shall comply with all relevant laws, regulations and ordinances and will correct conditions that led to adverse regulatory actions, if any.

- **Indicator 2.1.2** Landowner should obtain advice from appropriate qualified natural resource professionals or qualified contractors who are trained in, and familiar with, relevant laws, regulations and ordinances.

How the LMP Covers this Section:

- All landowners certified under this LMP agree to meet all federal, state, and local regulations. Understanding that while mistakes may occur in carrying out forest management activities, landowners must be committed to correcting inadvertent violations. A pattern of willful violation of relevant laws, regulations or ordinances is not acceptable. If there is evidence of past nonconformance, then the landowner must show proof of a good-faith effort to remedy the nonconformance. If the matter is tied up in court, then the landowner is only disqualified when a final adverse judgment is rendered, and the landowner refuses to comply with the ruling.
- Compliance with all relevant (applicable) laws can be verified by a three-tiered process:
 - Step 1 – Observation of conditions on the subject property
 - Step 2 – The landowner’s verbal or written claim of legal compliance
 - Step 3 – Research with the state Department of Natural Resources, local Natural Resource Conservation Service office or State Forestry Commission offices
 - If Step 1 and Step 2 do not raise any issues, then the qualified ATFS inspector or third-party assessor is not required to employ Step 3.

STANDARD 3 Reforestation and Afforestation

Performance Measure 3.1 Reforestation or afforestation shall be achieved by a suitable process that ensures adequate stocking levels.

- **Indicator 3.1.1** Harvested forest land shall achieve adequate stocking of desired species reflecting the landowner’s objectives, within five years after harvest, or within a time interval as specified by applicable regulation.

How the LMP Covers this Section:

- Under the silvicultural options outlined in this LMP, information is provided on the different strategies to achieve success in reforestation and afforestation efforts. The state of South Carolina does not specify a specific required stocking level, post-harvest activity, so landowners operating under this LMP agree to achieve adequate stocking of desired species based on their objectives within five years after harvest. ATFS Inspectors will document these efforts within the 004 inspection form to ensure conformance.

STANDARD 4 Air, Water and Soil Protection

Performance Measure 4.1 Landowner shall meet or exceed practices prescribed by State Forestry BMPs.

- **Indicator 4.1.1** Landowner shall implement specific state forestry BMPs that are applicable to the property.
- **Indicator 4.1.2** Landowner shall minimize road construction and other disturbances within riparian zones and wetlands.

Performance Measure 4.2 Landowner shall consider a range of forest management activities to forest health.

- **Indicator 4.2.1** Landowner should evaluate alternatives to pesticides for the prevention or control of pests, pathogens and unwanted vegetation to achieve specific management objectives.
- **Indicator 4.2.2** Pesticides used shall be approved by the Environmental Protection Agency (EPA) and applied, stored and disposed of in accordance with EPA-approved labels and by persons appropriately trained, licensed and supervised.

Performance Measure 4.3 When used, prescribed fire shall conform with landowner's objectives and pre-fire planning.

- **Indicator 4.3.1** Prescribed fire shall conform with the landowner's objectives and state and local laws and regulations

How the LMP Covers this Section:

- All landowners certified under this LMP agree to meet or exceed all South Carolina Best Management Practices for Forestry (SC BMPs for Forestry), even those that are voluntary, which are applicable to the property. When planning management activities that will cause any soil disturbance or require chemical application, the SC BMPs for Forestry should be consulted and applicable BMP methods employed. No field evidence of BMP implementation is expected where no management activity has occurred. However, if the property shows evidence of water quality impairment originating on the property that is not caused by the landowner's or designated representative's actions, the landowner is strongly encouraged to have plans for remediation. Some BMPs, such as those that are guidelines to enhance a desired species, should only apply where relevant to the property. Activities in riparian zones and wetlands shall comply with applicable BMPs. BMP manuals are generally quite detailed on recommended practices for road construction and other disturbances of riparian zones. If there is a point of confusion, the landowner or designated representative is advised to consult with a qualified natural resource professional who is experienced in forest road design and installation. Landowners should specify with qualified contractors that BMPs must be adhered to. In all cases, the primary concern is to avoid contaminating watercourses that are adjacent to the forest activity.

STANDARD 5 Fish, Wildlife, Biodiversity and Forest Health

Performance Measure 5.1 Forest management activities shall protect habitats and communities occupied by threatened or endangered species as required by law.

- **Indicator 5.1.1** Landowner shall confer with natural resource agencies, state natural resource heritage programs, qualified natural resource professionals or review other sources of information to determine occurrences of threatened or endangered species on the property and their habitat requirements.
- **Indicator 5.1.2** Forest management activities shall incorporate measures to protect identified threatened or endangered species on the property.

Performance Measure 5.2 Landowner should address the desired species and/or desired forest communities when conducting forest management activities, if consistent with landowner's objectives.

- **Indicator 5.2.1** Landowner should consult available and accessible information on management of the forest for desired species and/or forest communities and integrate it into forest management.

Performance Measure 5.3 Landowner should make practical efforts to promote forest health.

- **Indicator 5.3.1** Landowner should make practical efforts to promote forest health, including prevention, control or response to disturbances such as wildland fire, invasive species and other pests, pathogens or unwanted vegetation, to achieve specific management objectives.

Performance Measure 5.4 Where present, forest management activities should maintain or enhance forests of recognized importance (FORI).

- **Indicator 5.4.1** Appropriate to the scale and intensity of the situation, forest management activities should incorporate measures to contribute to the conservation of identified FORI.

How the LMP Covers this Section:

- The LMP database provides valuable information about the fish, wildlife, biodiversity and forest health of the program area. The database includes spatial information about where there are known occurrences of threatened and endangered species, the regional soil types, and documented areas of invasive species incursion. Foresters and ATFS Inspectors can also use the database to include information specific to a Tree Farm regarding forest health, such as additional species composition information or treatment information.
- In addition to the information available in the LMP database, landowners operating under this LMP should walk their property with a qualified natural resource professional to identify occurrences of threatened and endangered species on or near their property. Landowners are also encouraged to work with natural resource professionals to identify possible occurrences of any disease, invasive species or pest outbreak on their property and discuss the range of recommended management techniques to address these issues. This LMP also outlines the variety of native and exotic pest species that landowners may interact with in this region, as well as tactics to address these issues.
- Integrated pest management (IPM) is an excellent approach to controlling, suppressing or preventing pests and can take many forms. Preventative measures, efforts to improve forest health or, in some

other way, protect the property from injurious organisms are often the most practical and effective approaches. Pesticide applications may be used when other control measures are ineffective or impractical. While landowners and designated representatives are urged to take feasible actions to address pests, pathogens and unwanted vegetation, third-party assessors are advised that, in some cases, there may be no feasible options for controlling a pest or outbreak due to severity, scale and timing of onset. When herbicides are used, landowners are required to follow EPA regulations.

- When conducting prescribed burns, landowners operating under this LMP shall follow all state regulations and are encouraged to work with qualified professionals. Additional information about burning based on forest type is included in the following sections.
- Landowners are encouraged to maintain records of forestry related activities for at least three years.

STANDARD 6 Forest Aesthetics

Performance Measure 6.1 Landowner should manage the visual impacts of forest management activities consistent with the size of the forest, the scale and intensity of forest management activities and the location of the property.

- **Indicator 6.1.1** Forest management activities should apply visual quality measures compatible with appropriate silvicultural practices.

How the LMP Covers this Section:

- Forest aesthetics considerations can be incorporated into management planning with little cost to the landowner. Employing forest aesthetics considerations into the management plan can produce a much more visually appealing experience on property visits for owners, their guests and passers-by using nearby public roads. This LMP addresses aesthetic issues relevant to each of the common forest types in the region in their respective sections.

STANDARD 7 Protect Special Sites

Performance Measure 7.1 Forest management activities shall consider and maintain any special sites relevant on the property.

- **Indicator 7.1.1** Landowner shall make a reasonable effort to locate and protect special sites appropriate for the size of the forest and the scale and intensity of forest management activities.

How the LMP Covers this Section:

- Special sites of biological and geological significance may be identified through consultation undertaken related to the identification of FORIs and threatened or endangered species and communities (within Standard 5). In addition to publicly recognized special sites, landowners may designate sites of personal significance to them, such as a spot their grandparents cherished.
- Landowners or designated representatives shall identify special sites on management plan maps and, where appropriate, on the ground. However, some landowners may choose not to identify some special sites on a map or on the ground to protect these sites from vandalism or overuse. Landowners or

designated representatives shall make efforts to protect any known special sites especially during forest management activities. These efforts may include creating a vegetation buffer, fencing the area or otherwise distinguishing it from surrounding areas. Because special sites are often in the ground, measures may be taken to control erosion and limit soil disturbance. Landowners and designated representatives are advised to review their special sites map and protection plan with qualified natural resource professionals and qualified contractors assisting in forest management activities. After harvests, landowners and designated representatives are encouraged to follow up to ensure adequate protection.

STANDARD 8 Forest Product Harvest and Other Activities

Performance Measure 8.1 Landowner should use qualified natural resource professionals and qualified contractors when contracting for services.

- **Indicator 8.1.1** Landowner should seek qualified natural resource professionals and qualified contractors.
- **Indicator 8.1.2** Landowner should engage qualified contractors who carry appropriate insurance and comply with appropriate federal, state and local safety and fair labor rules, regulations and standard practices.
- **Indicator 8.1.3** Landowners should retain appropriate contracts or records for forest product harvests and other management activities to demonstrate conformance to the Standards

Performance Measure 8.2 Landowner shall monitor forest product harvests and other management activities to ensure they conform to their landowner objectives.

- **Indicator 8.2.1** Harvest, utilization, removal and other management activities shall be conducted in compliance with the landowner's objectives and to maintain the potential of the property to produce forest products and other benefits sustainably.

How the LMP Covers this Section:

- When conducting forestry activities, landowners must ensure that their actions and those taken on their behalf are in conformance with both the landowner's objectives and the ATFS Standards. To safeguard landowners from liability risks and protect their assets, landowners are encouraged to work with qualified natural resource professionals and contractors and review the Standards before planning management activities. If the landowner's objectives do not specify directives as to harvest, utilization and removals, regional norms and accepted practices are expected.
- Examples of forestry activities requiring review for AFF Standards compliance:
 - Harvest operations including timber and nontimber products
 - Site preparation and reforestation
 - Forest road construction and maintenance
 - Mineral extraction
 - Hunting and fishing
 - Invasive species control
 - Pest management

- Landowners are encouraged to discuss liability issues with their insurance agent and their attorney to gain a perspective on appropriate insurance minimums that they might require of contractors. When agreeing upon the terms of the contract, landowners and designated representatives are encouraged to stipulate that contractors must follow all relevant laws and regulations and should specify that appropriate state forestry BMPs must be adhered to. A qualified natural resource professional can help with this process.
- Other contract specifications might include:
 - Protection of special sites or habitats
 - Adherence to labor laws
 - Requirements for adequate insurance
 - Protection of soil and water integrity
 - Residual tree damage
 - Forest road maintenance and restoration
 - Fence and gate protection and/or restoration
 - Litter control
 - Hazardous material spill prevention and clean-up
- Generally, landowners are encouraged to retain contracts or records for management activities for three years.

1.4. Forest Stewardship Program Standards within the LMP

The Forest Stewardship Program (FSP) encourages long-term stewardship of important State and private forest landscapes, by assisting landowners to more actively manage their forest and related resources. The Program aids owners of forest land and other lands where good stewardship, including agroforestry applications, will enhance and sustain the long-term productivity of multiple forest resources and produce healthy, resilient forest landscapes. Special attention is given to landowners in landscape areas identified by State Forest Action Plans and those new to, or in the early stages of managing their land in a way that embodies multi-resource stewardship principles. The program provides landowners with the professional planning and technical assistance they need to keep their land in a productive and healthy condition. Assistance offered through the FSP also provides landowners with enhanced access to other USDA conservation programs, forest certification programs, and forest product and ecosystem service markets. Participation in the FSP is open to any non-industrial private forest landowners who are committed to the active management and stewardship of their forested properties for at least ten years. The FSP is not a cost share program. Cost-share assistance for plan implementation may be available through other programs.

The FSP Standards were addressed and evaluated during the completion of this LMP. More specifically, in order to provide an LMP that is “multi-resource in scope and adequately comprehensive with respect to forest ecosystem management,” the following plan element discussions are linked below:

(NOTE: In the event an element is discussed in multiple forest types, only the location in the first forest type where the element is discussed is linked below.)

- Soil and water
- Biological diversity
- Range
- Agroforestry
- Aesthetic quality and desired Timber species
- Recreation
- Wood and fiber production
- Fish and wildlife

- Threatened and endangered species
- Forest health and invasive species
- Conservation-based estate planning / legacy planning information
- Archeological, cultural, and historic sites
- Wetlands
- Fire
- Carbon Sequestration & Climate Resilience
- Forests of Recognized Importance (FORI)

1.5. A Forester's Field Guide for Using the Landscape Management Plan with Landowners

This guide is designed as a resource for foresters in using the landscape management plan to effectively provide assistance to landowners, while streamlining administrative and related elements of landowner engagement.

The landscape management plan is designed as a tool that foresters and other natural resource professionals may use to support landowners in their on-the-ground engagement that allows for economical access to programs that provide recognition of their stewardship and technical assistance and resources. While coordination with a landowner will likely be structured organically in a conversational tone and format, this field guide provides forest resource professionals a more structured approach to ensure all components of the LMP are addressed to meet certification standards. For instance, in some scenarios the initial meeting may occur anywhere (e.g. on the phone, in the office, on another landowner's property). It is important to capture as much pertinent information about the property, its history, size and location, and the general goals and objectives of the landowner. Using the information you obtain during this initial conversation, you will be more prepared for your meeting on the landowner's property.

Step 1 Preparing to Meet the Landowner

- Use the current LMP [geodatabase](#) to locate and characterize the landowner's property
 - Develop location and soils maps (NOTE: this may also be used to aid determination of applicable forest types)
 - Identify additional property characteristics (e.g. special sites, listed species potential, invasive concerns)
 - Determine current forest type(s) and acreage – may be verified during onsite consultation
- Review Typical Landowner and Landscape Objectives for the existing forest types anticipated on the property

Step 2 Meeting the Landowner

- Identifying Objectives:
 - Discuss the objectives of the landowner (during initial conversation and/or during onsite follow-up)
 - Probe each objective identified by the landowner to ensure you understand the underlying motivations and goals for the property. The landowner may have multiple objectives or difficulty articulating the objectives as they are described in the LMP. A clear understanding of the landowner's objectives streamlines the options needed to meet those objectives.
 - Review and suggest other objectives and how they may also meet the landowner's underlying goals. This may initiate a re-evaluation of landowner objectives.
- Review and discuss potential landscape objectives (if applicable) to determine if any correlations or commonalities exist with the landowner's objectives to support wider conservation goals. The landowner may be unaware of or gain interest in specific landscape objectives, creating a re-evaluation of landowner objectives. Some landowners may not be interested in or have objectives that share commonalities with landscape objectives. In either scenario, landowners are not required to commit to any landscape objectives or requirements.
- Based on the review of the landowner and potential landscape objectives, and the analysis of current site conditions, determine a target forest type(s) and the forest resources available to the landowner. This forest type(s) could be different or the same as the current forest type on the property.
- Based upon landowner objectives, potential landscape objectives, target forest type(s) and the geodatabase review, identify an actionable strategy using the silvicultural options identified in the LMP (by forest type) to meet the objectives.
- Provide advice, contacts, and technical support to the landowner of the implementation of the identified silvicultural options. Encourage or aid the landowner to document and retain records of the activities occurring on the property.

Step 3 After the Visit

- Contact the landowner and provide answers to any questions you were unable to answer during the visit. Additionally, prompt the landowner if they had any additional questions or comments arise following the last meeting. Provide additional support and encouragement for implementing the activities identified during the meeting. This follow-up is encouraged to occur between one week and one month following the meeting.
- Complete and process any paperwork or certification submittals required following the meeting.
- Using a landscape management tool makes follow-up support to landowners even more important. The LMP method depends on the relationship and engagement of the landowner and forest resource professional to meet the criteria for certification. This LMP allows landowners the flexibility to adaptively manage the property based on the results of silvicultural operations, gaining additional information (e.g. listed species), changing ecological (e.g. sea level rise) or market conditions (e.g. timber markets), and especially changing landowner (and landscape) objectives. Therefore, following up with the landowner not only promotes their engagement in active management but also allows them to modify their management strategies to meet these other dynamic conditions.

- Make a note in the relevant system of when follow-up should occur.
- Contact the landowner within 1 year to schedule a visit, assess activities implemented, determine if any changes have occurred to objectives, and determine if personal circumstances and/or the property have changed. This type of follow-through is strongly encouraged. Provide additional advice and technical support to the landowner, as needed. Depending on the forest type and the silvicultural options selected, a longer period between contact with the landowner may be appropriate. Optimistically, the landowner should be contacted annually to promote and foster their engagement in the active management of their property.

This guide also can be utilized for landowners with existing and/or outdated plans. The same process should be followed when replacing the existing or outdated plan, although much of the information needed for the initial step (1) may have already been completed. Additionally, the existing plan can be used during a review of the landowner's objectives, forest types and resources, and implementation activities. The additional information found in this LMP and the geodatabase will then be used to supplement and replace the existing plan.

1.6. A Landowner's Field Guide for Using the Landscape Management Plan

This guide is designed as a resource for landowners in using the landscape management plan to effectively interact with foresters, while streamlining administrative and related elements of engagement.

The landscape management plan is designed as a tool that foresters and other natural resource professionals may use to support landowners in their on-the-ground engagement that allows for economical access to programs that provide recognition of their stewardship and technical assistance and resources. While a landowner's interaction with a forester will likely be structured organically in a conversational tone and format, this field guide provides landowners additional knowledge of the process and a more structured approach to ensure all components of the LMP are addressed to meet certification standards. For instance, in some scenarios the initial meeting may occur anywhere (e.g. on the phone, in the office, on another landowner's property). Using the information you obtain during this initial conversation, you will be more prepared for the meeting with the forester on your property.

Step 1 Preparing to Meet the Forester

- Use the current LMP [geodatabase](#) to locate and characterize the natural features present on your property
 - Identify additional property characteristics (e.g. special sites, listed species potential, invasive concerns) that may need to be discussed with the forester
 - Determine current forest type(s) and acreage
- Review Typical Landowner and Landscape Objectives for the existing forest types anticipated on your property

Step 2 Meeting the Forester

- Identifying Objectives:
 - Discuss the objectives you have for the future management of your property (during initial conversation and/or during onsite follow-up)
 - Develop a method to communicate your objectives clearly to the forester. You may have multiple objectives or may need to phrase the objectives as they are described in the LMP.
- Review and discuss potential landscape objectives with the forester (if applicable) to determine if any correlations or commonalities exist with the objectives to support wider conservation goals. The forester may suggest possible landscape objectives that would be applicable to your specific situation or the properties/location of your land.
- Based on the review of your personal and potential landscape objectives, and the analysis of current site conditions, work with the forester to determine a target forest type(s) and the forest resources needed and available for this/these specific objectives(s). This forest type(s) could be different or the same as the current forest type on the property.
- Based upon the objectives you have for your land, potential landscape objectives that may be applicable, target forest type(s), and the geodatabase review, work with the forester to identify an actionable strategy using the silvicultural options identified in the LMP (by forest type).

Step 3 After the Visit

- Contact the forester with any questions that may have been unanswered during the visit or that may have arisen since last communication with the forester. This follow-up is encouraged to occur between one week and one month following the meeting.
- The LMP method depends on the relationship and engagement of the landowner and forest resource professional to meet the criteria for certification. This LMP allows landowners the flexibility to adaptively manage the property based on the results of silvicultural operations, gaining additional information (e.g. listed species), changing ecological (e.g. sea level rise) or market conditions (e.g. timber markets), and especially changing landowner (and landscape) objectives. Therefore, following up with the forester resource professional not only promotes engagement in active management but also allows modification of management strategies to meet these other dynamic conditions.
- Expect the forester to be in contact within one year to schedule a follow-up visit, assess any activities implemented, determine if any changes have occurred to objectives, and determine if personal circumstances and/or the property have changed. This type of follow-through is highly valuable to ensuring completion of any land management goals. Ask any additional questions and bring up any new concerns to the forester, as needed. Depending on the forest type and the silvicultural options selected, a longer period between contact with the forester may be appropriate. This level of contact should occur at least annually to encourage active, thoughtful management of the property.

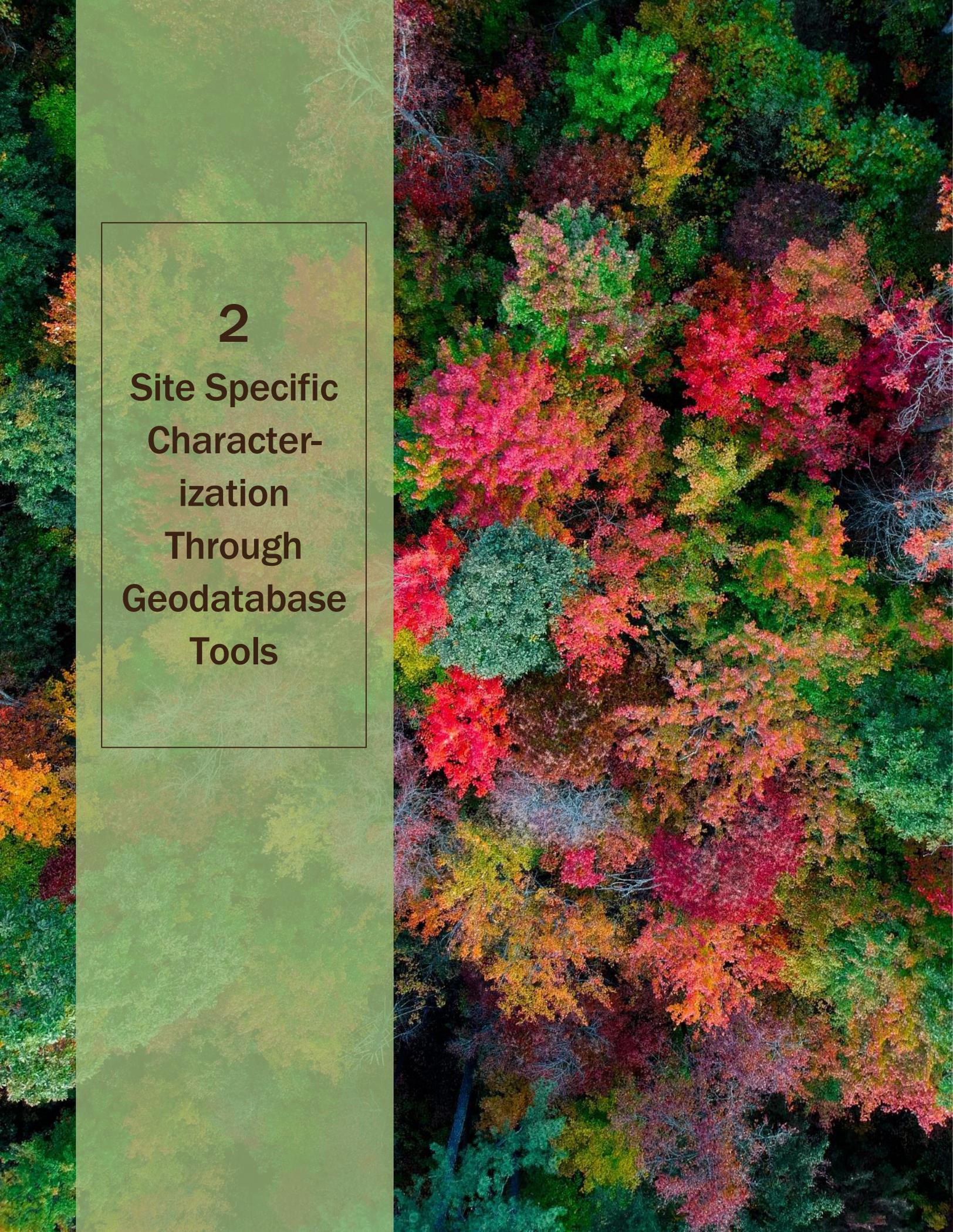
This guide also can be utilized for landowners with existing and/or outdated plans. The same process should be followed when replacing the existing or outdated plan, although much of the information needed for the initial step (1) may have already been completed. Additionally, the existing plan can be used during a review of the landowner's objectives, forest types and resources, and implementation activities. The additional

information found in this LMP and the geodatabase will then be used to supplement and replace the existing plan.

1.6.1. Landowner “Leave-Behind” Document

To ensure that landowners have a plan and strategy moving forward in the management of their forest, the SCFC has developed a “leave-behind” document to provide a roadmap toward each landowner being able to meet their objectives. Following Step 2 (during the visit with a forester) and during Step 3 (after the visit with a forester), the forester will provide the landowner with a brief (4-5 page) pamphlet containing a stand level assessment of the landowner’s property, recommendations on how to best manage those stands to meet the landowner’s stated goals and objectives, and a stand map that also shows the property boundary and its associated natural features and landforms. Recommendations for management will also be outlined in an activity schedule that details property actions needed for the next 10 years.

Additionally, landowners will receive within the leave-behind a notice to consult the LMP for information concerning calculating their timber basis before any harvests. This will help landowners to avoid having to pay timber taxes on gross revenues and not net revenues; this information may be particularly useful for landowners who have recently inherited or purchased their land and are not yet sufficiently aware of the process. It should be noted that the leave-behind is a supplemental document provided through the SCFC to work in conjunction with the LMP for the state of South Carolina. While the leave-behind may reference the LMP and its contents, it is not an official part of the document and has been developed internally by the SCFC for use by its project foresters.



2

Site Specific Character- ization Through Geodatabase Tools



2. SITE SPECIFIC CHARACTERIZATION THROUGH GEODATABASE TOOLS

To adequately determine the existing conditions present on any reference site evaluated using this LMP, a GIS-based evaluation tool was developed for this process. This geodatabase represents the accumulation and organization of the most site-specific geospatial characterization tools that are publicly available within the LMP. The strategic goal of this geodatabase is to provide forest resource professionals with a geospatial tool that presents tabular data helpful in developing forest management goals and recommendations.

2.1. Instructions for Use

This geodatabase will require a geographic information system (GIS) to view, summarize and manipulate both the geospatial and tabular data included. Numerous fee-based and free shareware style geospatial applications are available and accessible for natural resource professionals, including both SCFC foresters as well as consulting foresters across the state.

The geodatabase is designed to allow the user to calculate and summarize data for each geodatabase layer on the landowner's parcel of property. By selecting the landowner's tract location using publicly available county tax records, the exact location of the reference parcel can be identified. Multiple parcels can also be selected simultaneously if landowner property boundaries encompass multiple tax parcels. After identifying the referenced property, users can toggle and select between individual and/or multiple geospatial resource layers that will present summarized tabular data for the selected location. For instance, a user could determine the haul distance to specific product mills and develop detailed soil and potential hydrologic impact maps to determine harvesting operations. Likewise, users could quickly determine which potential threatened and endangered species or nearby invasive species could be present on their referenced site.

2.2. Geodatabase Layer Descriptions

The following 21 geospatial layers and aerial imagery layer comprise the LMP geodatabase used for site specific characterization of subject landowner properties. Each layer is referenced by its name within the geodatabase and information is provided about the source layers' name, location, and a brief description of the content found within the layer.

1. Historical Structures

- Layer Source Name: Historic Structures - ArchSite, 2019, SC ArchSite
- Description: This dataset contains historic structure locations and attributes as recorded by the South Carolina Institute of Archaeology and Anthropology (SCIAA) and the South Carolina Department of Archives and History (SCDAH).
- Layer Source Location: <http://www.scarchsite.org/>

2. Cemeteries

- Layer Source Name: South Carolina Cemeteries, 2019, Open Street Map
- Description: This dataset contains historic cemetery boundaries and basic cemetery attributes.
- Layer Source Location: <https://mygeodata.cloud/data/download/osm/cemeteries/united-states-of-america-south-carolina><http://www.fgdI.org/metadataexplorer/explorer.jsp>

3. Wetlands

- Layer Source Name: USFWS National Wetlands Inventory-Polygons-October 2014, FGDL
- Description: This data set represents the extent, approximate location and type of wetlands and deepwater habitats in the conterminous United States. These data delineate the areal extent of wetlands and surface waters as defined by Cowardin et al. (1979). Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and near shore coastal waters. Some deepwater reef communities (coral or tubercid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery. By policy, the Service also excludes certain types of "farmed wetlands" as may be defined by the Food Security Act or that do not coincide with the Cowardin et al. definition. Contact the Service's Regional Wetland Coordinator for additional information on what types of farmed wetlands are included on wetland maps
- Layer Source Location: <https://www.fws.gov/wetlands/data/Mapper.html>

4. Hydrologic Units

- Layer Source Name: Watershed Boundary Dataset – 2018, USGS
- Description: [The Watershed Boundary Dataset \(WBD\)](#) is a nationally consistent watershed dataset that is subdivided into 6 levels (12-digit HUCs) and is available from the USGS and [USDA-NRCS-National Cartographic and Geospatial Center's \(NCGC\)](#).
- Layer Source Location: <https://water.usgs.gov/GIS/huc.html>

5. Hydrology

- Layer Source Name: National Hydrography Dataset – 2018, USGS
- Description: [National Hydrography Dataset \(NHD\)](#) is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD data was originally developed at 1:100,000-scale and exists at that scale for the whole country. This high-resolution NHD, generally developed at 1:24,000/1:12,000 scale, adds detail to the original 1:100,000-scale NHD. (Data for Alaska, Puerto Rico and the Virgin Islands was developed at high-resolution, not 1:100,000 scale.) Local resolution NHD is being developed where partners and data exist. The NHD contains reach codes for networked features, flow direction, names, and centerline representations for areal water bodies. Reaches are also defined on waterbodies and the approximate shorelines of the Great Lakes, the Atlantic and Pacific Oceans and the Gulf of Mexico. The NHD also incorporates the National Spatial Data Infrastructure framework criteria established by the Federal Geographic Data Committee. The NHD is a national framework for assigning reach addresses to water-related entities, such as industrial discharges, drinking water supplies, fish habitat areas, wild and scenic rivers. Reach addresses establish the locations of these entities relative to one another within

the NHD surface water drainage network, much like addresses on streets. Once linked to the NHD by their reach addresses, the upstream/downstream relationships of these water-related entities--and any associated information about them--can be analyzed using software tools ranging from spreadsheets to geographic information systems (GIS). GIS can also be used to combine NHD-based network analysis with other data layers, such as soils, land use and population, to help understand and display their respective effects upon one another. Furthermore, because the NHD provides a nationally consistent framework for addressing and analysis, water-related information linked to reach addresses by one organization (national, state, local) can be shared with other organizations and easily integrated into many different types of applications to the benefit of all.

- Layer Source Location: <https://viewer.nationalmap.gov/basic/?basemap=b1&category=nhd&title=NHD%20View#productGroupSearch>

6. Listed Species

- Layer Source Name: U.S. FISH AND WILDLIFE SERVICE ENVIRONMENTAL CONSERVATION ONLINE SYSTEM (ECOS) FEDERALLY LISTED SPECIES CRITICAL HABITAT-2019, USFWS
- Description: This data set represents federally listed species known to be present in each of the counties that make up South Carolina within the U.S. Fish and Wildlife Service. The Environmental Conservation Online System (ECOS) is a gateway web site that provides access to data systems in the U.S. Fish and Wildlife Service (Service) and other government data sources. This central point of access assists Service personnel in managing data and information, and it provides public access to information from numerous Service databases. As of 02/13/2015 the data in this report has been updated to use a different set of information. Results are based on where the species is believed to or known to occur. The FWS feels utilizing this data set is a better representation of species occurrence. Note: there may be other federally listed species that are not currently known or expected to occur in this state but are covered by the ESA wherever they are found; Thus if new surveys detected them in this state they are still covered by the ESA. The FWS is using the best information available on this date to generate this list. The data is not meant as a substitute for site-specific surveys. The code key below and in the User Notes denotes the species designation. Code Key: E=Endangered, T=Threatened, PE=Proposed Endangered, PT=Proposed Threatened, C=Candidate, BGEPA=Bald and Golden Eagle Protection Act.
- Layer Source Location: <https://ecos.fws.gov/ecp/report/table/critical-habitat.html>

7. Wildlife Refuges

- Layer Source Name: SDE.refuge, South Carolina Department of Natural Resources (SCDNR)
- Description: This is a statewide Refuge data set based on the 1:24,000 DLG Refuge data sets by topographic quadrangle. Digital line graph (DLG) are digital representations of cartographic information. DLG's of map features are converted to digital form from maps and related sources. Large-scale DLG data are derived from USGS 1:20,000-, 1:24,000-, and 1:25,000-scale 7.5-minute topographic quadrangle maps. Large-scale DLG data are available in nine categories: (1) hypsography, (2) hydrography, (3) vegetative surface cover, (4) non-vegetative features, (5) boundaries, (6) survey control and markers, (7) transportation, (8) manmade features, (9) Public Land Survey System. All DLG data distributed by the USGS are DLG - Level 3 (DLG-3), which means the data contain a full range of attribute codes, have full topological structuring, and have passed certain quality-control checks.

- Layer Source Location: <http://www.dnr.sc.gov/GIS/gisdnrdata.html>

8. Critical Habitat

- Layer Source Name: U.S. FWS Threatened & Endangered Species Active Critical Habitat Report
- Description: Spatial data for active proposed and final critical habitat for threatened and endangered species.
- Layer Source Location: <http://ecos.fws.gov/ecp/report/table/critical-habitat.html>

9. Sea Level

- Layer Source Name: Sea Level Rise
- Description: These layers show the rise of sea level from 0-6 feet.
- Layer Source Location: <https://coast.noaa.gov/slrdata/>

10. EDDMaps

- Layer Source Name: EDDMaps
- Description: Point data of invasive species collected by EDDMaps users.
- Layer Source Location: <https://www.eddmaps.org/tools/>

11. Counties

- Layer Source Name: South Carolina County Boundaries January 3, 2018, Data.gov
- Description: This dataset contains the boundaries of South Carolina's 46 counties. The Current County Subdivision State-based shapefiles contain the attributes for all County subdivisions, which are the primary divisions of counties and their equivalent entities for the reporting of Census Bureau data. They include legally-recognized minor civil divisions (MCDs) and statistical census county divisions (CCDs), and unorganized territories.
- Layer Source Location: <https://catalog.data.gov/dataset/tiger-line-shapefile-2016-state-south-carolina-current-county-subdivision-state-based>

12. Roads

- Layer Source Name: USGS 1:24,000 Roads
- Description: This coverage contains the digital line graphs (DLG) for the state of South Carolina as compiled by the Earth Science information center of the U.S. Geological Survey. The RDS24 coverage is a subset of all transportation data from the DLG data files derived from the 1:24,000-scale and other large-scale maps. This dataset has been updated from the previous version on FGDL 3.0.
- Layer Source Location: <https://catalog.data.gov/dataset/usgs-1-24000-scale-quadrangle-for-roads-mo-1957dbca3>

Soil

- Layer Source Name: Soil Survey Spatial and Tabular Data
- Description: This dataset contains the boundaries and descriptions of soil types.
- Layer Source Location: <https://gdg.sc.egov.usda.gov/GDGOrder.aspx>

13. Parcels > 10 acres

- For users of this LMP certifying landowners in the American Tree Farm System, parcel data is available in the state's CRM. All other users are recommended to search their state and local county's Geographic Information System (GIS) website to confirm the presence/absence of parcel data for their property of interest, as the availability of parcel data varies based on the state and county of residence.. All other layers in Section 2's geodatabase are functional independent of parcel data being present.

14. ICLUS Population Projections

- Layer Source Name: ICLUS v1.3 Population Projections, 2019
- Description: The Integrated Climate and Land-Use Scenarios (ICLUS) project developed land-use outputs that are based on a downscaled version of the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (SRES) social, economic, and demographic storylines. ICLUS outputs are derived from a pair of models. A demographic model generates county-level population estimates that are distributed by a spatial allocation model (SERGoM v3) as housing density across the landscape. Land-use outputs were developed for the four main SRES storylines and a baseline ("base case"). The model is run for the conterminous USA and output is available for each scenario by decade to 2100. In addition to housing density at a 1 hectare spatial resolution, this project also generated estimates of impervious surface at a resolution of 1 square kilometer. This shapefile holds population data for all counties of the conterminous USA for all decades (2010-2100) and SRES population growth scenarios (A1, A2, B1, B2), as well as a 'base case' (BC) scenario, for use in the Integrated Climate and Land Use Scenarios (ICLUS) project.
- Layer Source Location: <https://edg.epa.gov/metadata/catalog/search/resource/details.page?uuid=%7B1BB3ECBD-3EEB-43F3-AF78-B1196ACCC732%7D>

15. Projected Future Land Use

- Layer Source Name: ICLUS Version 2 Land Use Projections for the Fourth National Climate Assessment SSP2LUS_v2.1_land_use_southeast_ssp2, 2019
- Description: SSP2 is a "middle-of-the-road" projection of future land use, where social, economic and technological trends do not shift markedly from historical patterns, resulting in a U.S. population of 455 million people by 2100. Domestic migration trends remain consistent with the recent past. This version of the ICLUS model does not include climate change projections to dynamically update location-specific amenities when calculating migration. These projections will include the "nocc" label in the file name to indicate this difference.
- Layer Source Location: <https://catalog.data.gov/dataset/iclus-v2-1-land-use-projections-for-the-fourth-national-climate-assessment-ssp2/resource/44d69c26-0826-4f80-9c13-beb79168ef5f>

16. Imagery: World Imagery

- Layer Source Name: ESRI World Imagery, 2019
- Description: This map service presents satellite imagery for the world and high-resolution imagery for the United States and other areas around the world.
- Layer Source Location: <http://www.esri.com/software/arcgis/arcgisonline>

17. South Carolina Land Use Data

- Layer Source Name: National Land Cover Database, 2011
- Description: This layer represents the finest level of thematic detail for the GAP/LANDFIRE National Terrestrial Ecosystems 2011 land cover. This data layer is the 2011 update of the National Gap Analysis Program Land Cover Data Version 2.2 for the conterminous U.S. The map legend includes types described by NatureServe's Ecological Systems Classification as well as land use classes described in the National Land Cover Dataset 2011. These data cover the entire continental U.S. and are a continuous data layer. These raster data have a 30 m x 30m cell resolution.
- Layer Source Locations: <https://www.mrlc.gov/data>

18. National Conservation Easement Database (NCED) Conservation Easement Boundaries

- Layer Source Name: NCED Easements
- Description: The National Conservation Easement Database (NCED) is the first national database of conservation easement information, compiling records from land trusts and public agencies throughout the United States. This public-private partnership brings together national conservation groups, local and regional land trusts, and local, state and federal agencies around a common objective. The NCED is an initiative of the U.S. Endowment for Forestry and Communities. The current NCED team includes Ducks Unlimited and The Trust for Public Land. The NCED team collaborates on data acquisition and standards with the USGS Core Science Analytics, Synthesis, and Library's [Protected Areas Database of the United States \(PAD-US\)](#). The NCED team also collaborates with agencies and organizations nationwide, including The Nature Conservancy and Land Trust Alliance.
- Layer Source Locations: <https://www.conservationeasement.us/interactivemap/>

19. The Nature Conservancy Conservation (TNC) Easement Boundary

- Layer Source Name: TNC Lands
- Description: This dataset includes The Nature Conservancy's properties / preserves, easements and leases (areas TNC holds a legal interest in). Boundaries are regularly collected from TNC's US State Chapters and are matched with attributes from the TNC legal database. This dataset is regularly provided to the CBI [PAD-US](#), [NCED](#), and [USGS GAP](#) protected area databases, but this dataset provides additional attributes & more frequent updates. Some historic data is included, but the focus is on current holdings.
- Layer Source Locations: <http://www.tnclands.tnc.org/>

Mill Locations

- Layer Source Name: South Carolina Primary and Secondary Forest Products Mill Locations
- Description: The South Carolina Forest Products Mill Directory includes all primary and secondary mills in the state. Primary forest products mills purchase roundwood or in-woods chips and manufacture a lumber, paper or energy-related product. Secondary forest product businesses purchase a primary product and manufacture a value-added product like trusses, packaging or furniture.
- Layer Source Locations: <http://www.trees.sc.gov/refind.htm>

20. South Atlantic Landscape Conservation Cooperative: Southeast Conservation Blueprint

- Layer Source Name: Southeast Blueprint Version 3.0
- Description: The Southeast Conservation Blueprint is the primary product of the Southeast Conservation Adaptation Strategy. It is a living, spatial plan that identifies important areas for conservation and restoration across the Southeast and Caribbean. The Blueprint stitches together smaller subregional plans into one consistent map, incorporating the best available information about key species, ecosystems, and future threats. More than 1,700 people from 500 different organizations have actively participated in its development so far.
- Layer Source Locations: <https://www.southatlanticlcc.org/blueprint/>



3
Ecoregions
(Level III)



3. ECOREGIONS (LEVEL III)

The Environmental Protection Agency (EPA) has developed ecoregions to group the continental United States into areas where the type and quality of environmental resources, including biotic and abiotic factors, are generally similar. These resources can include patterns and similarities between geology, soils, vegetation, climate, hydrology, wildlife, and other comparative categories. This division of resources is generated from the research of Omernik (1987) as well as mapping created from collaboration between EPA regional offices, other federal agencies, and state agencies.

Ecoregions are classified into a 4-level Roman numeral scheme, with Level I being the broadest ecoregion category with 12 ecoregion divisions and Level IV being the most specific with 967 ecoregion divisions nationwide. For the purpose of this LMP, the 105 ecoregions contained in the Level III classification were deemed to be specific enough to address the management requirements across the state.

South Carolina contains 5 Level III and 14 Level IV ecoregions within its borders (Figure 1). From north to south, these Level III ecoregions and their associated Level IV ecoregions are: Blue Ridge (Southern Crystalline Ridges and Mountains), Piedmont (Southern Inner Piedmont, Southern Outer Piedmont, Carolina Slate Belt, Triassic Basins, Kings Mountain), Southeastern Plains (Sand Hills, Atlantic Southern Loam Plains, Southeastern Floodplains and Low Terraces), Middle Atlantic Coastal Plain (Carolinian Barrier Islands and Coastal Marshes, Carolina Flatwoods, Mid-Atlantic Floodplains and Low Terraces), and Southern Coastal Plain (Floodplains and Low Terraces, Sea Islands/Coastal Marsh). It was determined that, while at times certain Level IV ecoregions may exhibit an important distinction in ecology of South Carolina, the Level IV ecoregions provided too high of a degree of specificity for a LMP designed to focus on landscape-level functions and difference; thus, the Level III ecoregions were selected as the focus of the LMP. For additional information on the ecoregions of South Carolina and their associated waterways, landforms, and land uses, consult [Chapter 4 of the South Carolina State Wildlife Action Plan](#).



Figure 1 The 5 Level-III Ecoregions of South Carolina

While the majority of eastern South Carolina is composed of varying levels of plains, the western portion of the state begins to transition to rolling uplands in the Piedmont and then to the foothills of the Blue Ridge mountains in the extreme northwest corner of the state. A brief description of characteristics for each Level III ecoregion will be given below. Also, in combination with these descriptions, geospatial analysis of the geodatabase layers listed above in section 2 will provide insight into features that are or may be present within a landowner’s parcel. The boundaries of each ecoregion can be displayed with all natural/environmental features shown overlaid in order to give the landowner information about their land as well as the surrounding ecoregion. This information will alert the landowner to any potential listed species or sensitive forest features present in or around their property.

3.1. Blue Ridge

The Blue Ridge (BR; Figure 2) ecoregion is unique in many aspects compared to the remainder of the ecoregions within South Carolina, due to it being part of the Blue Ridge mountain chain that intersects the extreme northwest part of the state. In South Carolina, the Blue Ridge is comprised of parts of Greenville, Oconee, and Pickens counties. While being the smallest ecoregion within South Carolina, the BR provides many different species found nowhere else in the state. In fact, the southern Blue Ridge is one of the richest regions for biodiversity within the eastern United States. See [Table 1](#) for the Federally listed species present within the Blue Ridge ecoregion. Species ranges were taken from USFWS species range data through map graphics. Information regarding the forest types inhabited by these species can be found below in [Section 5.1.4 Wildlife and Habitat Conservation](#). Most of this ecoregion is comprised of mostly forested slopes; cool, clear streams; and topographically rugged terrain. The Blue Ridge substrate includes a wide range of metamorphic, acid rocks with occasional inclusions of mafic and ultramafic rocks. Within the ecoregion, tree species exhibit a wide range of diversity as well. Communities range from oak forests and northern hardwoods to spruce-fir forests and hemlock, with the topographic relief of the ecoregion providing habitat for many species found nowhere else within the Southeastern U.S.

Table 1 Federally threatened and endangered species present within the South Carolina Level III Ecoregions

Species	Blue Ridge	Piedmont	Southeastern Plains	Middle Atlantic Coastal Plain	Southern Coastal Plain
American chaffseed				X	X
American alligator			X	X	X
Atlantic sturgeon			X	X	X
Bachman’s warbler				X	X
Bald eagle	X	X	X		X
Black-spored quillwort	X	X			
Bog turtle	X	X			
Bunched arrowhead		X			
Canby’s dropwort			X	X	X
Carolina heelsplitter		X	X		

Species	Blue Ridge	Piedmont	Southeastern Plains	Middle Atlantic Coastal Plain	Southern Coastal Plain
Dwarf-flowered heartleaf		X			
Florida manatee				X	X
Frosted flatwoods salamander				X	X
Gopher tortoise		X	X	X	X
Gulf sturgeon		X	X		X
Harperella		X	X		
Indiana myotis	X				
Inflated heelsplitter		X			X
Miccosukee gooseberry		X			
Michaux's sumac		X	X		
Mountain sweet pitcher-plant	X	X			
Northern long-eared bat	X	X		X	X
Persistent trillium	X				
Pondberry			X	X	X
Pool sprite		X			
Red-cockaded woodpecker			X	X	X
Reflexed blue-eyed grass		X			
Relict trillium		X	X		
Rocky gnome lichen		X			
Rough-leaved loosestrife		X	X		
Schweinitz's sunflower		X			
Seabeach amaranth			X	X	X
Shortnose sturgeon			X	X	X
Small whorled pogonia	X	X			
Smooth coneflower	X	X	X		
Swamp-pink		X			
White fringeless orchid		X			
Wood stork			X	X	X

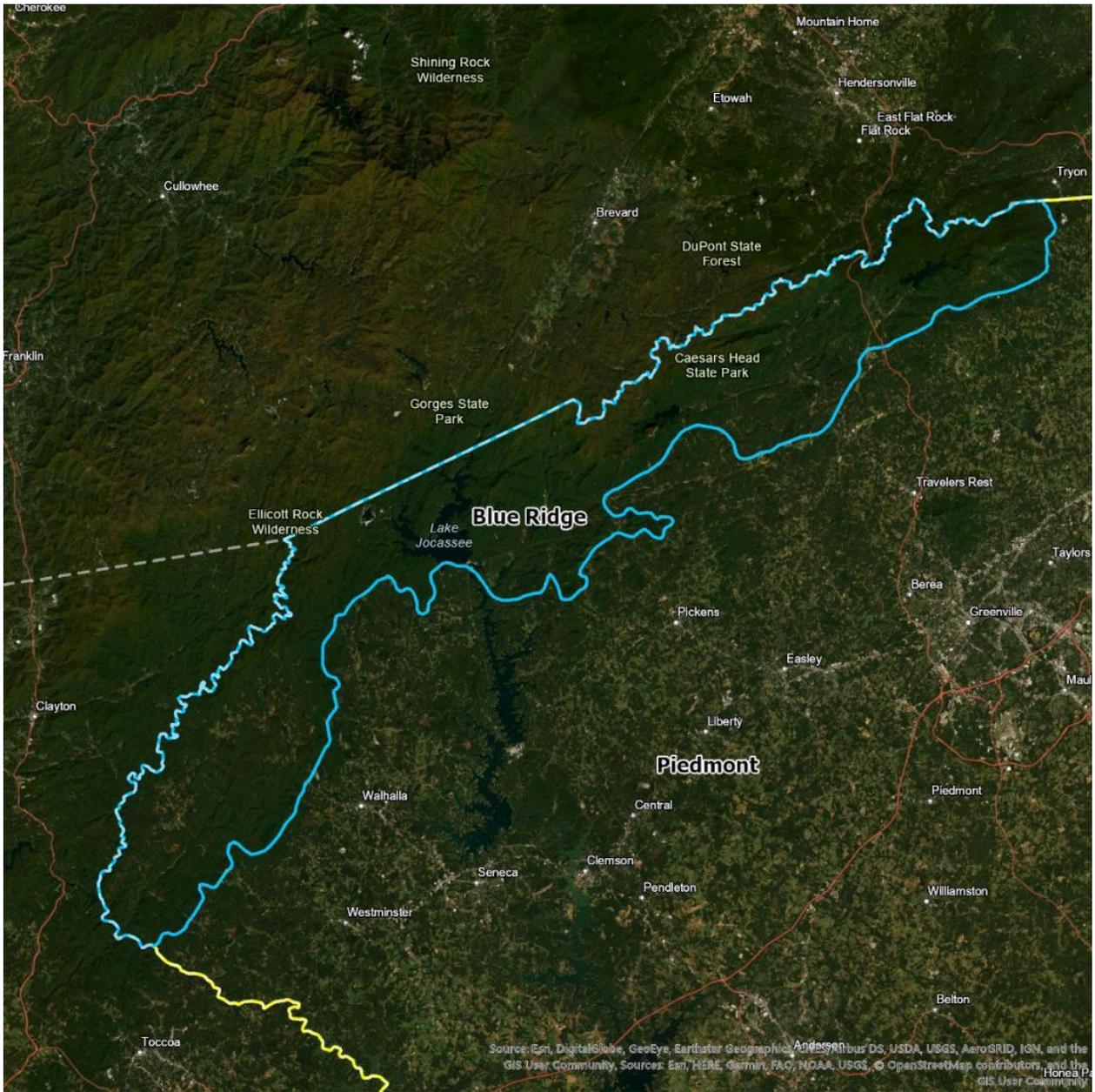


Figure 2 The Blue Ridge Level-III Ecoregion

3.1.1. Forest Types Within Ecoregion

The Blue Ridge ecoregion is primarily recognized for its diversity in hardwood varieties. These habitats occur in association with hardwood slope forests and other topographic features, and include such forests as beech gap forests, mountain cove forests, and Appalachian oak forests. Pine are found to a lesser extent within this ecoregion, although some instances of loblolly pine-hardwood and shortleaf pine-hardwood forest types can be found. Habitats at lower elevations within BR are similar ecologically to the adjacent Piedmont. However, as previously mentioned, upland hardwood forest types are dominant through the BR ecoregion.

3.2. Piedmont

The Piedmont (Figure 3) ecoregion is a large landscape that stretches northeast-southwest throughout the Carolinas. The Piedmont region largely represents a landscape transition from the Blue Ridge and other mountainous ecoregions to the west to the relatively flat plains leading to the Atlantic to the east. In South Carolina, the Piedmont is comprised of parts of Abbeville, Anderson, Cherokee, Chester, Edgefield, Fairfield, Greenville, Greenwood, Kershaw, Lancaster, Laurens, Lexington, McCormick, Newberry, Oconee, Pickens, Richland, Saluda, Spartanburg, Union, and York Counties. Most of the ecoregion is irregular plains with a mixture of rolling hills. Soils in this ecoregion are generally finer-textured than the coastal plain ecoregions to the east, while there also exists a population of Precambrian and Paleozoic metamorphic and igneous rocks. While once largely cultivated, the predominant land cover of the Piedmont is currently planted pine and some areas of pine that have reverted to hardwood woodlands with successional pine interspersed. See [Table 1](#) for the Federally listed species present within the Piedmont.

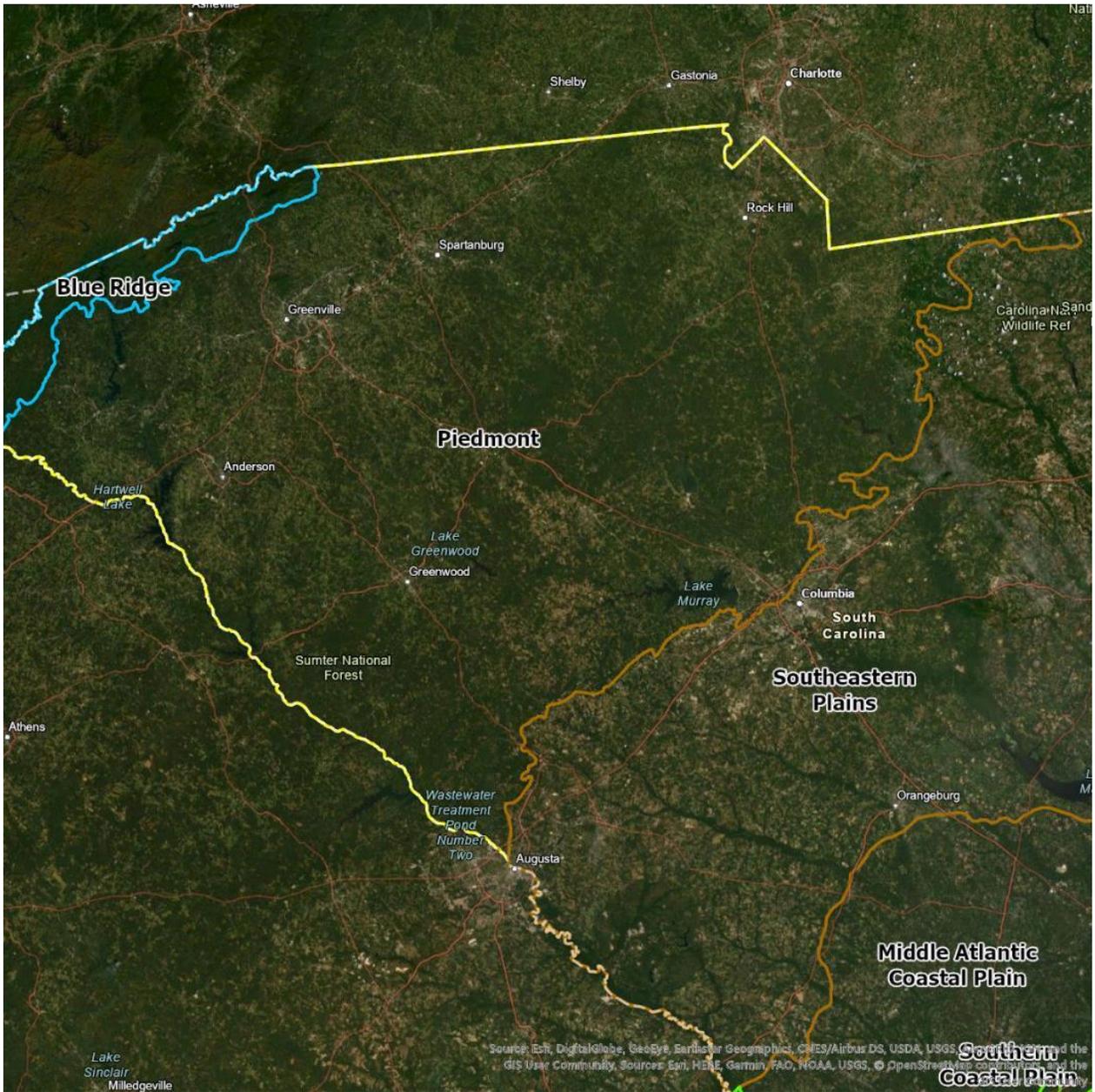


Figure 3 The Piedmont Level-III Ecoregion

3.2.1. Forest Types Within Ecoregion

The Piedmont is characterized mainly by its abundance of upland habitat due to its topography. Historic species commonly found in the natural pine-hardwood forests included shortleaf pine (*Pinus echinata*) and loblolly pine (*Pinus taeda*), while hardwood populations included white oak (*Quercus alba*), southern red oak (*Quercus falcata*), post oak (*Quercus stellata*), and various hickory species (*Carya* spp.). All four of the pine forest types (loblolly dominated, longleaf dominated, shortleaf pine/hardwood mixed, loblolly pine/hardwood mixed) are found to varying degrees within the Piedmont. Upland hardwood forest types are also well-represented in this region. Due to the mostly upland habitat within the Piedmont, the bottomland forest types are not as present within this ecoregion; however, bottomland forest habitat may be found along the major rivers of the region.

3.3. Southeastern Plains

The Southeastern Plains (SP; Figure 4) ecoregion exists between the Piedmont and Middle Atlantic Coastal Plain and consists of some irregular plains with broad interstream regions. In South Carolina, the Southeastern Plains is comprised of parts of Aiken, Allendale, Bamberg, Barnwell, Calhoun, Chesterfield, Clarendon, Darlington, Dillon, Florence, Horry, Kershaw, Lee, Lexington, Marion, Marlboro, Orangeburg, Richland, and Sumter counties. The SP contains greater elevations and relief than the Middle Atlantic Coastal Plain to the immediate east, but less than the hilly Piedmont ecoregion to the west. Streams present in this ecoregion are generally low-gradient and consist of sandy substrate. Historically, the SP was dominated by old growth natural longleaf pine, which an intermixture of hardwoods. Currently, land use within the SP is a mixture of natural forest, pine plantations, pasture, and crops. See [Table 1](#) for the Federally listed species present within the Southeastern Plains.

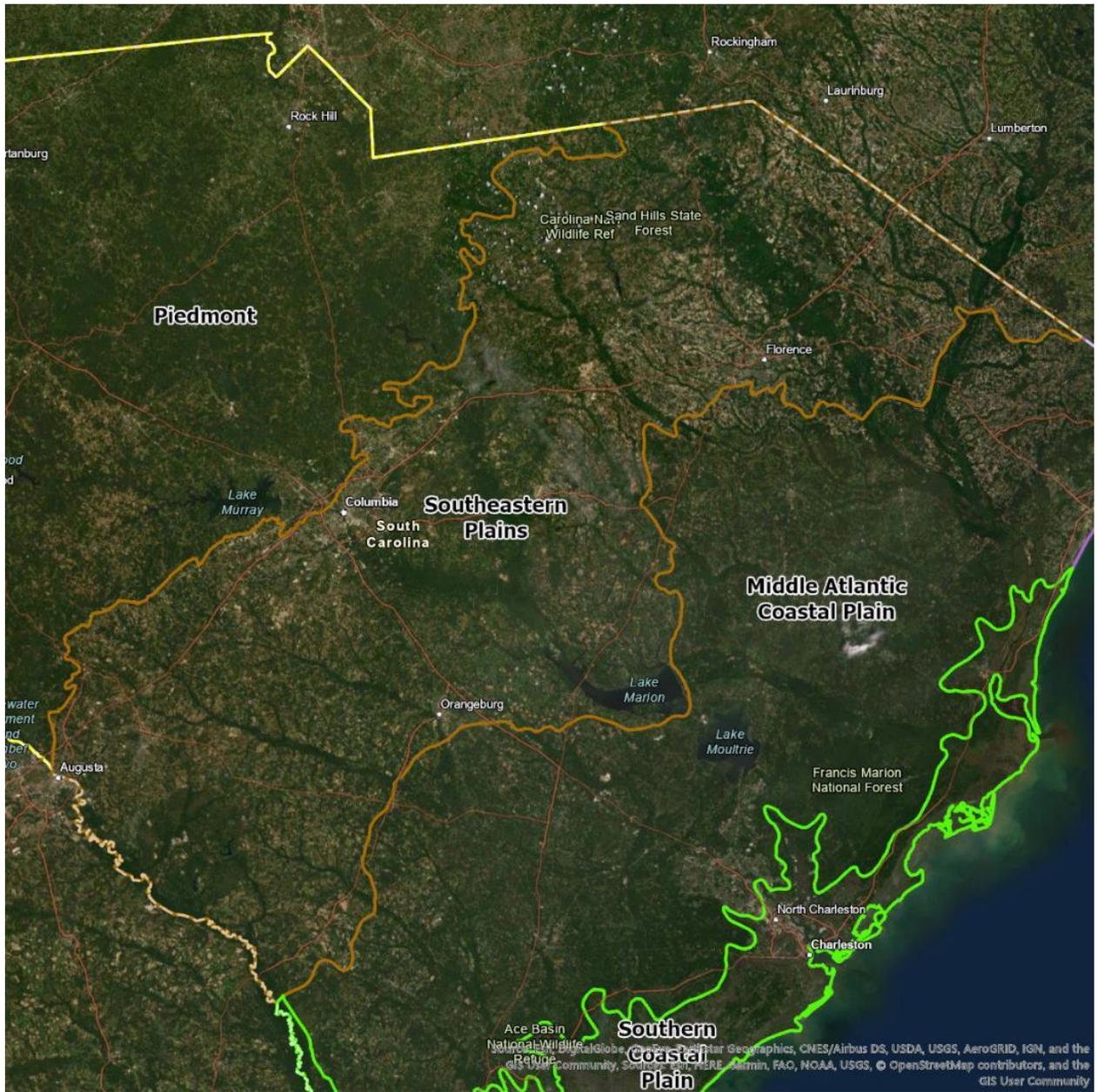


Figure 4 The Southeastern Plains Level-III Ecoregion

3.3.1. Sandhills Level IV Ecoregion

While not a Level III ecoregion, the Sandhills portion of South Carolina is distinct enough to warrant its own consideration. The Sandhills ecoregion is a landform found within the Southeastern Plains ecoregion, immediately adjacent to the Piedmont ecoregion, and is characterized by rolling hills and deep, coarse sands. Compared to the adjacent Piedmont and Middle Atlantic Coastal Plain ecoregions, the Sandhills exhibit relatively unbroken upland forested habitat (SC SWAP). Due to the deep, nutrient-deprived soils of the Sandhills as well as the frequent lightning-induced fires that occur, plant species must be well-adapted to inhabit this landform. Turkey oak and longleaf pine are major components of the Sandhills ecoregion's overstory due to their drought and fire resistance, as the Sandhills support one of the remaining longleaf pine strongholds in the Southeastern U.S. Other fire-adapted grass species inhabit the understory. The longleaf pine dominant forest type is frequently found within the Sandhills (University of Georgia Savannah River Ecology Laboratory 2019).

3.3.2. Forest Types Within Ecoregion

The SP is highly diverse in both different forest types and natural communities, as well as species richness. The many different upland habitats range from the rolling longleaf uplands to wet pine flatwoods, while wetlands range from floodplains to Carolina bays. The flat topography and fertile soils of the region make good habitat for both upland and bottomland forest types, with bottomland forests occurring in floodplains, depressional wetlands, and Carolina bays. Loblolly dominates the varying pine forest types found in SP, although longleaf occurs frequently and most pine species are represented within the ecoregion.

3.4. Middle Atlantic Coastal Plain

The Middle Atlantic Coastal Plain (MACP; Figure 5) ecoregion consists of a mixture of cropland, natural woodland, and forests. In South Carolina, the Middle Atlantic Coastal Plain is comprised of parts of Allendale, Bamberg, Beaufort, Berkeley, Charleston, Clarendon, Colleton, Dorchester, Florence, Georgetown, Hampton, Horry, Jasper, Lee, Marion, Orangeburg, Sumter, and Williamsburg counties. This ecoregion is predominantly comprised of flat plains, with swamps, marshes, and estuaries common through the MACP. Soils in this ecoregion are often poorly drained, and the region has both coarse and fine textured soils compared to the mostly coarse soil of the bordering Southern Coastal Plain. The MACP is a very diverse region, generating many new to science species while containing ecological communities that shift location over time. See [Table 1](#) for the Federally listed species present within the Middle Atlantic Coastal Plain.

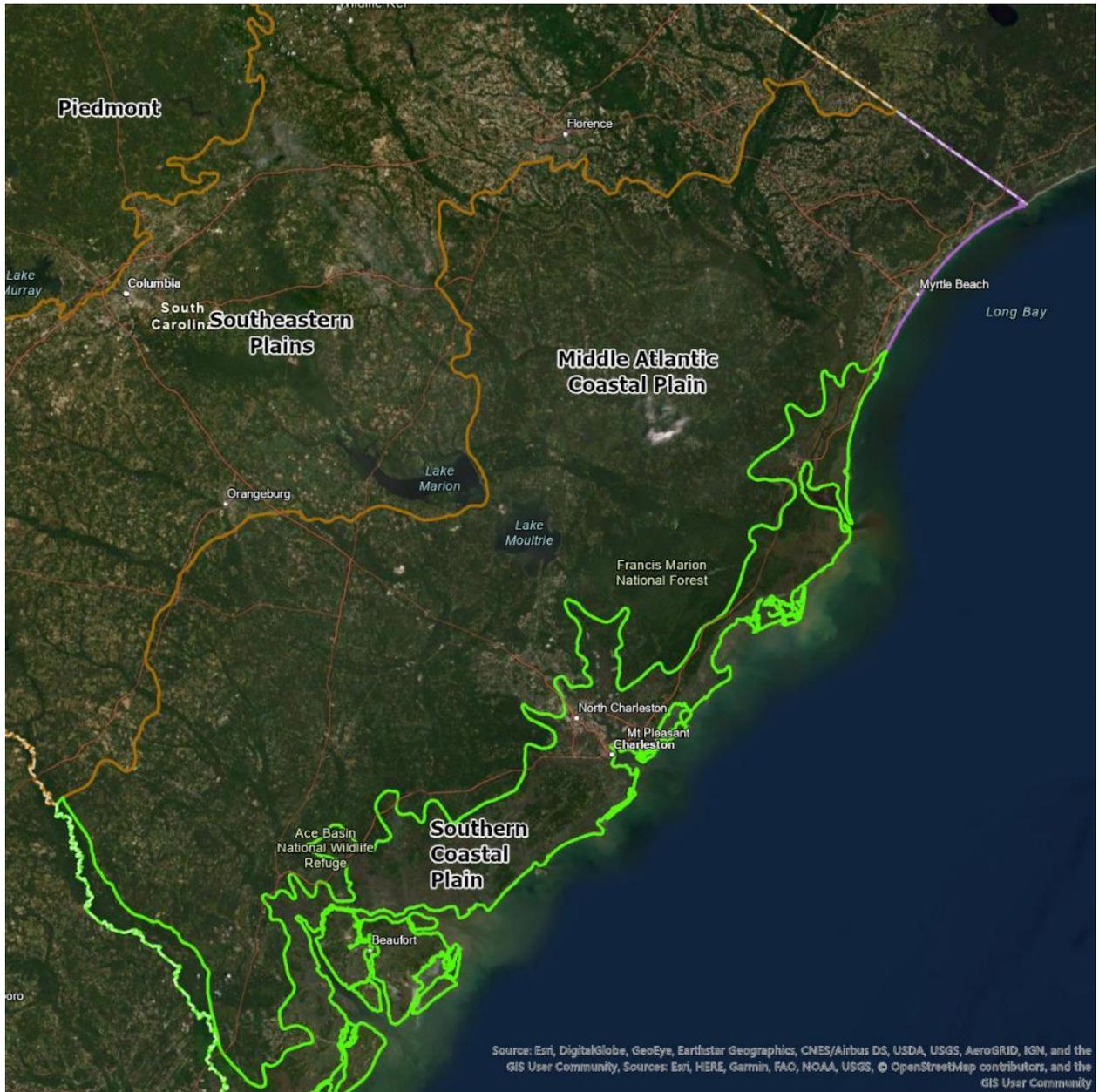


Figure 5 The Middle Atlantic Coastal Plain Level-III Ecoregion

3.4.1. Forest Types Within Ecoregion

The Middle Atlantic Coastal Plain supports a wide range of different forest types and natural communities. While longleaf pine once dominated forest types in the MACP, all pine species are present to some extent with loblolly pine having assumed the dominant role. Pine plantations for lumber and pulpwood are typical within this ecoregion. The relatively flat topography and fertile soils of the region are suitable for both upland and bottomland forest types, with the bottomland forests occurring mainly in riparian areas. The MACP also contains a multitude of marshes, estuaries, swamps, pocosins, tupelo-cypress mixed habitats, Carolina bays, and barrier islands. Maritime forests can be found in sandy substrate along high-relief areas along the northeastern coast of South Carolina.

3.5. Southern Coastal Plain

The Southern Coastal Plain (SCP; Figure 6) ecoregion is an extensive portion of land stretching from southern South Carolina west to eastern Louisiana, ending at the Mississippi Alluvial Plain ecoregion. In South Carolina, the Southern Coastal Plain is comprised of parts of Beaufort, Berkeley, Charleston, Colleton, Georgetown, and Jasper counties. Along with the coastal plains and lowlands, this ecoregion also encompasses barrier islands, coastal lagoons, marshes, and swampy lowlands along the coast. This low, flat ecoregion supports a variety of habitats that thrive on its sandy soil, which once included longleaf pine flatwoods and savannas in addition to a variety of other pine and hardwood species tolerant of wet, sandy soils. Although longleaf pine still occurs here, current land cover in this ecoregion now mainly consists of mainly loblolly and occasional slash pine with scattered instances of hardwood forests, bottomland hardwoods, and pastureland. See [Table 1](#) for the Federally listed species present within the Southern Coastal Plains.

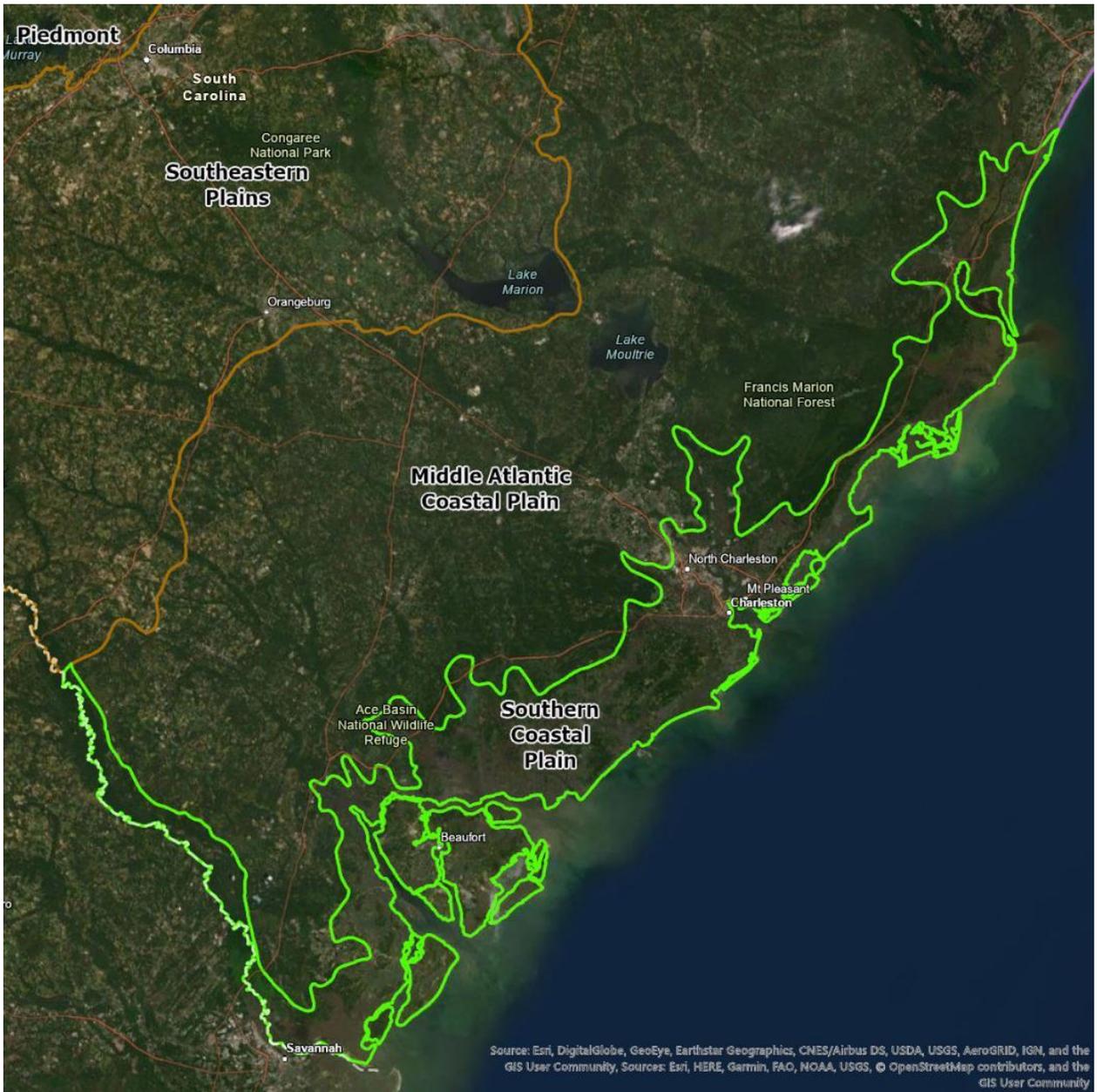


Figure 6 The Southern Coastal Plain Level-III Ecoregion

3.5.1. Forest Types Within Ecoregion

The Southern Coastal Plain supports a wide range of different forest types and natural communities and represents a transition in forest types from the more western Middle Atlantic Coastal Plain. While the SCP has flat topography similar to the MACP, the soils of this ecoregion are much less fertile due to the increasingly sandy substrate closer to the Atlantic Ocean. These depleted, infertile soils are more suitable for predominantly loblolly and slash pine forest types, although the other pine forest types may be found to some degree. All the other South Carolina forest types are found within the SCP to a varying degree, with their locations dependent mostly on topography. Maritime forests are a major forest type component with the SCP due to its raised dune topography.

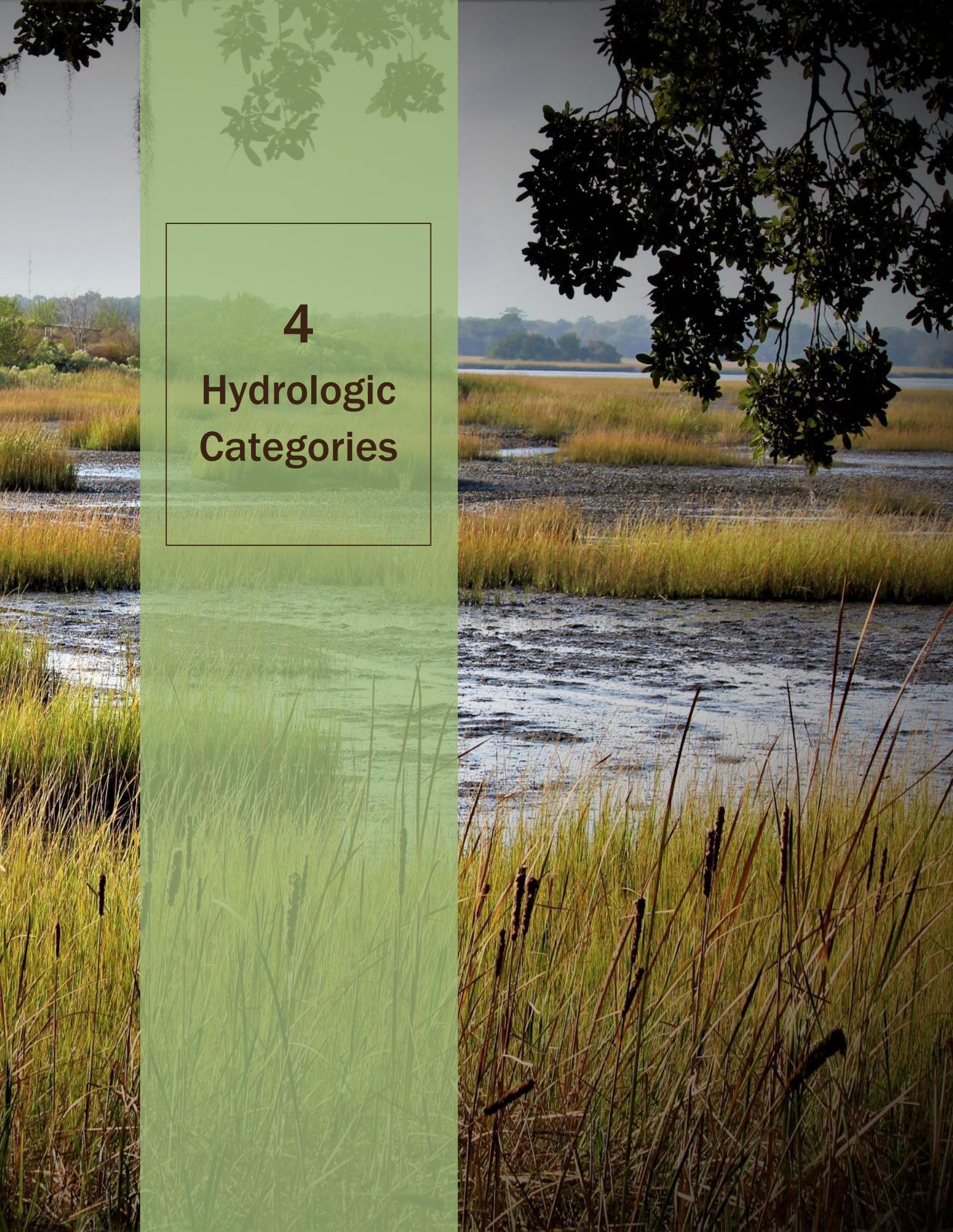
3.6. Ecoregions Application to Landscape Management Plan

Ecoregions are an important and distinct division of the landscape that takes into consideration geographical landforms, natural features (soils, vegetation, etc.), species populations, climate, and other environmental factors. It is important for landowners to realize the properties of the ecoregion in which they are located, as these features will be more or less applicable to certain landscape and/or landowner objectives and may drive the consideration of how to manage one's property.

While landowner objectives are somewhat standard across the different ecoregions, as a landowner will have similar goals independently of their location, some landscape objectives vary more greatly depending on the ecoregion. For example, if the landscape objective identified by the landowner is to support healthy forest products, the ecoregion where the landowner resides will have an effect on what types of forest products to develop on their land. While pine forest products and the mills that process them are more prevalent in the SP, MACP, and SCP ecoregions, the BR ecoregion specializes more in hardwood chips and other hardwood products.

The protection of wildlife populations and species, if it is the goal of the landowner, differs by ecoregion as well. As seen in Table 1, species have a certain niche and preferred environment where they are found. For instance, a landowner interested in preserving and enhancing habitat for the frosted flatwood salamander should have land located in the MACP and SCP where the landscape provides the vernal wetlands surrounded by pine forest needed for this species to exist; trying to provide habitat for this species within the BR would provide no benefit as it is out of their range. In addition to landowners' independent efforts to protect species and their related habitats, Conservation Initiatives have a geographic range where they can be applied. The National Bobwhite Conservation Initiative (NBCI) is most applicable in the central and eastern ecoregions of South Carolina due to the abundance of potential bobwhite habitat.

The landscape objective of Ecological Restoration also varies by ecoregion. The longleaf pine and wiregrass community is a good restoration example. Many landowners in the SP and MACP ecoregions own land with deep, well-drained sandy soils that were historically populated by native longleaf pine communities. Since longleaf pine also can meet aesthetic, recreation, legacy planning, and revenue objectives, many landowners are interested in its restoration. Landowners in the BR or Piedmont ecoregions, however, would not have this option of longleaf restoration due to their location outside of longleaf habitat within the state. Other restoration opportunities may be available in these ecoregions, however, such as shortleaf pine initiatives. It is important to understand the restoration opportunities available to landowners within each ecoregion in the state.



4

Hydrologic Categories



4. HYDROLOGIC CATEGORIES

The United States Geological Survey (USGS) has developed the hierarchical system of Hydrologic Unit Codes (HUCs) in order to categorize and group waterbodies and watersheds of the U.S. There are 4 main levels of HUCs within the United States, ranging from the broad, 2-digit regions to the 8-digit cataloging unit, more commonly known as sub-basins. Sub-basins can then be further subdivided into 10-digit watersheds and 12-digit subwatersheds. For the purpose of this LMP, the 4-digit subregions were deemed appropriate to address the management requirements and landscape differences across the state.

South Carolina contains all or part of three 4-digit subregions (Figure 7): 0304-Pee Dee, 0305-Edisto-Santee, and 0306-Ogeechee-Savannah. Within these 4-digit subregions, South Carolina has 34 distinct 8-digit watersheds. These 8-digit HUCs, as mentioned above, represent too specific an area for a Landscape Management Plan due to the lack of large-scale landscape differences between these divisions. These 8-digit HUCs can be viewed through the geodatabase tool (see [Section 2.2.3](#)). Also, geospatial analysis of the geodatabase layers listed above in Section 2 will provide insight into features that are or may be present within a landowner's parcel. The boundaries of each HUC, 2-to-16-digit, can be displayed with all natural/environmental features shown overlaid in order to give the landowner information about their land as well as the surrounding watershed.

Within the different watersheds of South Carolina, multiple watershed initiatives exist. These initiatives are largely focused on providing technical assistance to landowners to increase awareness about the connection between healthy forests and a healthy water supply as well as assisting foresters and landowners to implement sustainable and safe forest management practices. A major initiative in South Carolina is the [Lower Savannah River Watershed Initiative](#). This initiative is sponsored through the Longleaf Alliance and, in conjunction with landowners in the Savannah River watershed, strives to provide technical assistance to landowners in order to increase awareness about connections between healthy forests and clean, safe drinking water. The Lower Savannah River Watershed Initiative also assists landowners in implementing BMPs beneficial for sustained water quality.

The National Water Quality Initiative (NWQI) is a NRCS initiative applicable to forest lands throughout the U.S. (NRCS 2019). The NWQI program offer financial and technical assistance to forest landowners that are interested in improving water quality as well as aquatic habitats if their land falls within priority watersheds with impaired streams. A focus of the program is to provide conservation measures to landowners that will effectively control and trap nutrient and manure runoff, thereby decreasing nutrient loads to already impaired stream habitats. In South Carolina, the only priority watershed is the Upper Saluda, a SCDHEC 319 water quality priority area. The Upper Saluda flows through the Saluda reservoir before emptying into Lake Murray, and is potentially contaminated through failing septic systems and cattle watering in creeks. Enrolling in this program provides financial assistance while also improving water quality within the state.

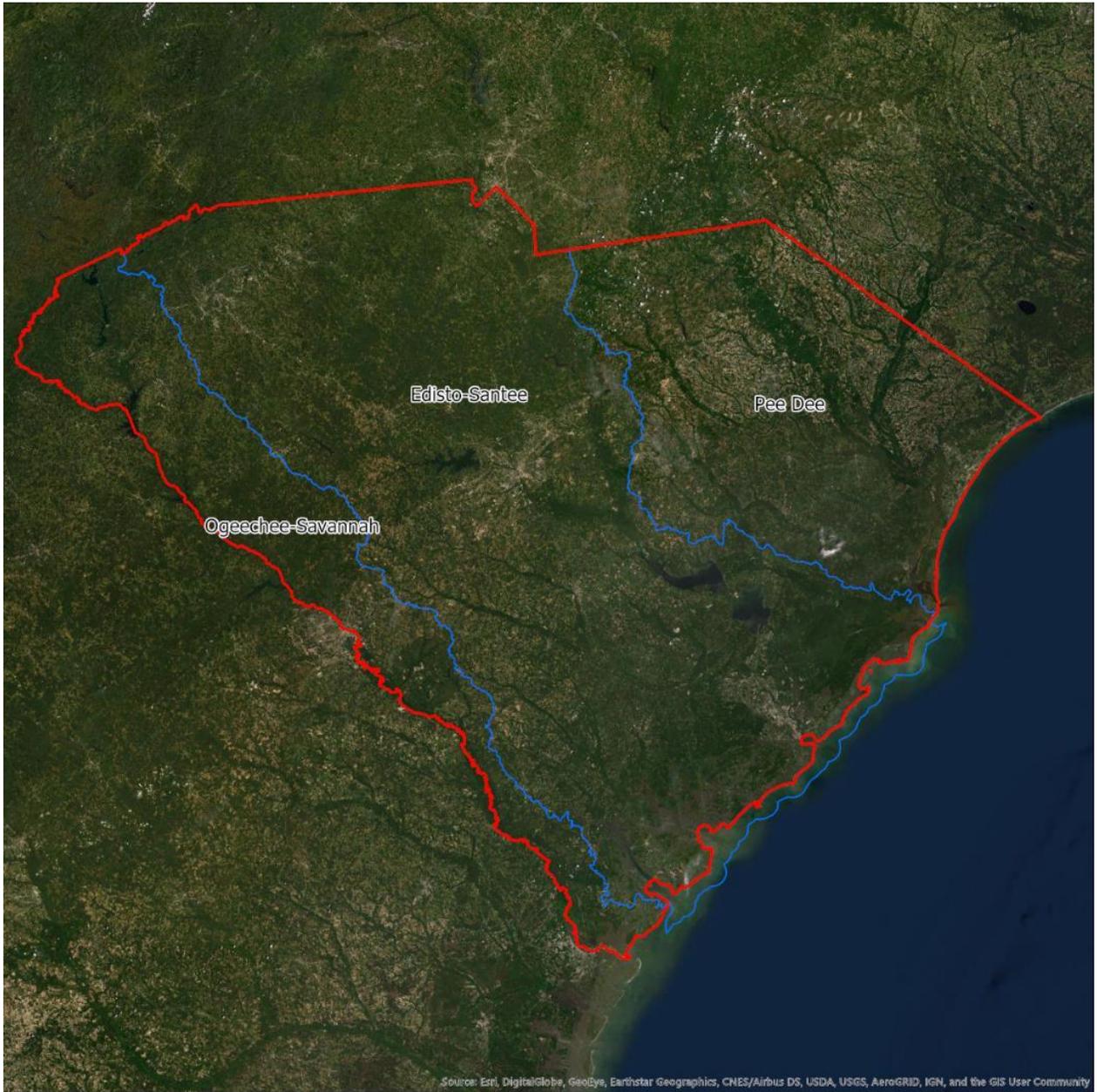


Figure 7 4-Digit Hydrologic Unit Codes (HUCs) of South Carolina

5

Objectives





5. OBJECTIVES

Forest management objectives generally fall into two major levels of classification: Landowner and Landscape Objectives. Landowner objectives are those considerations important to a landowner upon which achievement measures the relative success or failure of the management in their perspective. These objectives can be used by forest resource professionals to provide, design, and implement services important to the landowner. Landowner objectives are often easily determined because they are also considered forest resources common to all forest types (e.g., aesthetics and recreation). Landscape objectives are those objectives identified on a national, state, and/or ecoregional level that provide the greatest benefit towards forested ecosystem restoration, maintenance, and enhancement. Landowner objectives may also change or adapt after becoming aware of landscape objectives.

Generally following the determination of a landowner's objectives, forest resource professionals can identify the landscape level objectives that the landowner's objectives support. Landowner and landscape level objectives can be the same (e.g., hydrologic protection and conservation) or provide opportunities to support and enhance each other. For example, a landowner may consider their primary objectives Wildlife Management and Ecological Restoration. Through forest management activities to promote these objectives, the landowner could also be supporting landscape objectives like Wildlife Habitat Management, Rare Plant and Animal Protection, Non-native and Invasive Species Management, and in some cases Utilization of Prescribed Fire and/or Longleaf Pine Restoration.

5.1. Common Landscape Objectives

The landscape-level objectives discussed below are important to all forest types and should be considered for each landowner. They are summarized below, rather than included in the forest types discussion due to their uniform applicability across all forest types. Some of the landscape objectives were derived from South Carolina's Statewide Forest Resource Assessment and Strategy, and some were taken from a stakeholder group comprised of various forest resource professionals and governmental agencies within South Carolina. Forest type-specific landscape objectives are discussed below.

5.1.1. Forest Land Conservation and Retention

For this LMP, conservation is defined as the process of maintaining a natural resource (e.g. forested ecosystem) for perpetual use. This definition inherently associates conservation with the proper use of ecological processes to maintain the forested ecosystem. The term conservation is generally credited to Gifford Pinchot, who served as President Teddy Roosevelt's head of the US Forest Service in the early 20th century (Trefethen 1975). Some landowners have a conservation objective because they would like to see their forest ownership remain intact and capable of being passed down from generation to generation. Landowners with a conservation objective may utilize other consumptive use objectives like revenue generation or hunting and fishing recreation.

Conservation and legacy planning are both founded upon the desire to ensure future use of a natural resource. Many landowners seek to achieve a balance between conservation and legacy planning objectives

by utilizing [silvicultural tools](#) to mimic ecological processes (conservation) and restricting human activities outside their interests (legacy planning).

All forest types can be managed in a [conservation](#)-oriented manner. This can be accomplished using multiple-use management by balancing utilization and protection of timber, wildlife, rare plants, recreation and hydrology. Pine forests are fire dependent and require frequent application of [prescribed fire](#) for ecological maintenance; hardwood forest types do not require these fire-related management techniques. Forest types may also be managed differently depending on the [ecoregion](#) they are located within.

The retention of forest land within South Carolina has been designated a priority through the Statewide Forest Resource Assessment and Strategy. While forests were the predominant land cover within the state in 2010 (67%, 13 million acres), South Carolina continues to experience increased urbanization, with urban land gaining nearly 1.5 million acres from 1968 to 2006 (Conner et al. 2009). Urbanization has been the primary cause of deforestation in South Carolina and, with the state population expected to continue growing rapidly into the future, will remain a major threat to forest land retention. In the recent past, government programs such as the [Conservation Reserve Program](#) have worked to help keep forested land in South Carolina relatively stable over time, with agricultural lands being converted to forests to offset the increasing urbanization. However, this conversion has slowed and it appears that there may soon be a net loss in forestland in the state.

A key component in retaining forest land is to limit the amount of parcelization and its subsequent fragmentation of the forest landscape occurring within South Carolina forests. As land is parcelized into smaller and smaller land holdings, the forest becomes fragmented and other land uses interrupt the forest flow. As forest land is fragmented and forested tracts are isolated from each other, wildlife are negatively impacted due to the breakup of the continuity of their habitat. Also, the availability of timber, water quality and forest manageability are likely negatively impacted by this parcelization ([South Carolina's Statewide Forest Resources Assessment and Strategy](#)).

To combat the threat posed to forests by urbanization, the SCFC has created multiple objectives to facilitate the retention of these forested lands. They are:

- Collaborate with other natural resource organizations to identify and conserve high quality forest ecosystems and landscapes,
- Actively seek out grants, federal funds and other income sources to expand the state forest system, with the primary goal of acquiring tracts contiguous to existing properties, and
- Utilize Stewardship Contracting and Agreement Authorities in collaboration with the USDA Forest Service to benefit landscape scale ecosystem restoration projects on both public and private lands near federal lands.

5.1.1.1. Urban Sprawl and Wildland Urban Interface

A certain aspect of the Forest Land Retention landscape objective that has come under focus more recently than some is managing urban sprawl and its associated wildland-urban interface (South Carolina Statewide Forest Resource Assessment and Strategy, 2010). The wildland urban interface (WUI) is composed of both

interface (housing present in the vicinity of wildland) and intermix (housing and wildland vegetation are continuous) communities, where housing is present at or over one structure per 40 acres.

This increasing threat of wildland urban interface in the state of South Carolina can be attributed to the increased population growth statewide, especially with a large portion of the population leaving urban areas and moving into the suburbs. This ingress into rural areas has been targeted as a factor that can affect forest sustainability soon. Below are some of the factors listed in the Forest Resource Assessment and Strategy plan.

5.1.1.1.1. Water

The conversion of forest land to urban use poses a threat to the sustainability of South Carolina's water quality and quantity. With less forestland to effectively process rainfall, impervious, urban surfaces generate an increase in storm runoff and streamflow that can lead to increased erosion rates, overbank flooding, and sedimentation rates. An additional effect of forest loss is that pollutants and fertilizers can reach larger water bodies through flow over impervious surfaces. Also, development in rural areas tends to occur near the headwaters of streams and rivers, which may affect all of South Carolina's aquatic species located downstream of development that are susceptible to pollutants and changes in water composition/temperature.

5.1.1.1.2. Biodiversity

While some species have been able to adapt over time to the gradual encroachment of urbanization into their rural habitats and the changes this has caused to the natural resources they require, others are much more susceptible to changes in or around their habitat. These species require management to help prevent further population declines due to encroachment of anthropogenic effects and their subsequent habitat loss. For example, a group of species that once populated longleaf pine savannas, such as gopher tortoise, red-cockaded woodpecker, and other species, have found their populations become threatened as their habitat has been lost and degraded due to urban growth and development.

5.1.1.1.3. Wildfire

As the urban sprawl encroaches on natural forest habitats, the proximity of civilization to habitat that encounters frequent wildfires places more lives and properties at risk from the damages of fire. This proximity demands that safeguards and precautions are in place to ensure public safety. In South Carolina, the South Carolina Forestry Commission (SCFC) combats an average of 3,000 wildfires a year, with nearly 98% of these stemming from human actions (South Carolina Forestry Commission 2010). Two major methods to accomplish this safety are wildfire suppression and prescribed fire. Wildfire suppression is a reactive measure, ensuring that all forestry personnel are properly trained in the logistics and strategy needed to properly contain a wildfire once it is burning.

Prescribed burning, however, is a preventative measure to proactively control fuel loads within forest habitats and help to limit the intensity that wildfire may reach when they occur. The increasing scope of the WUI presents challenges to this in the form of increased planning time needed to adequately prepare citizens for pending prescribed burns, as well as the complexity of planning burns to limit the impacts of smoke on surrounding communities.

To help reduce the loss of homes to wildfire, especially in the Wildland Urban Interface, the South Carolina Forestry Commission actively promotes the [FireWise](#) program throughout the state (National Fire Protection Association 2019). This national initiative encourages developers and homeowners to create more fire-resistant neighborhoods through less flammable landscaping, keeping lower limbs trimmed on yards trees, and removing flammable materials from roofs and under decks. Also, the SCFC conducts wildfire risk assessments which can be used to create action plans for communities. As of 2010, South Carolina had 33 communities nationally recognized by FireWise.

5.1.2. Support Healthy Forest Products Industry

This LMP promotes maintaining a [healthy forest products](#) industry in South Carolina through sustainable forest management practices. This can be achieved through carefully planned timber harvests and timely site preparation and reforestation. Certification through the [American Tree Farm System \(ATFS\)](#) also supports sustainable forestry and adds value to timber markets. Many forest products companies need certified wood to be able to compete globally, so third-party certification through ATFS or other certifying bodies helps support these companies.

[SC BMPs for Forestry](#) also support a healthy forest products industry through practices that protect and enhance water and soil quality. By voluntarily conducting safe, responsible, and sustainable forestry practices, over-regulation is avoided, which helps keep [timber markets](#) alive and thriving.

Another way to support the forest products industry is through the practice of regulated forestry. The concept of a “regulated” or “normal” forest is integral to forest management in South Carolina. A regulated forest is at its core an ideal forest structure and is represented through a forest with an equal number of acres in each different age class. A regulated forest must have age and size classes represented in such a proportion and be growing consistently at such rates so that annual yields of products representing desired size and quality can be obtained through perpetuity (Davis and Johnson 1997).

A regulated forest will produce the maximum amount of fiber, on average, per year. Consequently, a regulated forest also produces the most money over time from the following: maintaining high average growth rates, diversification of product classes, frequency of payments, and compounding interest. Having a regulated forest also helps satisfy multiple other different landscape or landowner objectives. A regulated forest can provide net habitat for wildlife on an annual basis ([Wildlife Management and Protection](#)), always supplies sustainable products for perpetuity ([Support Healthy Forest Products Industry](#)), and can create a forest that is visually pleasing ([Aesthetics](#)) while providing a steady supply of revenue ([Economic Return](#)). Additional information concerning creating a regulated forest can be obtained through a discussion with a forest resource professional.

5.1.3. Watershed Protection and Restoration

South Carolina contains several major [watersheds](#) including the Savannah, Saluda, Edisto, Salkehatchie, Broad, Catawba, Santee, and Pee Dee Rivers among many others. Well-managed forests help protect these watersheds and ensure clean drinking water, waterways and healthy aquatic habitats.

In order to protect these watersheds and ensure that they continue to provide high-quality water resources, the SCFC cooperates with the [South Carolina Department of Health and Environmental Control \(SCDHEC\)](#) to

aggressively promote adherence to [SC BMPs for Forestry](#). Silvicultural and agricultural BMPs are often implemented and promoted to ensure these operations do not impair water quality in the region. In many cases [SC BMPs for Forestry](#) such as wetland harvest restrictions, road construction guidelines, and streamside management zones (SMZ's), enhance water quality, helping to restore watersheds. [SC BMPs for Forestry](#) are voluntary yet widely followed, which helps avoid mandatory regulation on these practices while protecting water quality. Watershed restoration also involves other forest operations such as replacing and improving culverts and installing hard-surface low water crossings.

To best implement the above BMPs, the SCFC has created objectives within the Statewide Forest Resource Assessment and Strategy. These goals are many-faceted and aim to enhance the environmental and public benefits of South Carolina's trees and forests. They are:

- Improve delivery of pre-harvest planning and BMP recommendations through the Courtesy Exam Program to protect water quality and site productivity during forestry operations,
- Provide classroom and field BMP training for forestry contractors, private landowners, industry, SCFC employees, and other agencies through the Timber Operations Professional (TOP) training program, in cooperation with industry and through SCFC workshops,
- Encourage contractors to include BMP compliance statements in their contracts,
- Work with the Forestry Association of SC, Association of Consulting Foresters, Clemson University, SC Department of Health and Environmental Control, SC Timber Producers Association, county landowners' associations, and other organizations to encourage landowners, loggers, foresters, and contractors to request courtesy BMP examinations,
- Continue BMP monitoring to document success and provide opportunities for education of landowners, loggers, and forestry professionals,
- Respond to BMP complaints and provide technical expertise to appropriate enforcement agencies,
- Periodically review Best Management Practices (BMP) guidelines and update as needed to better protect water quality,
- Update cooperative agreements with state and federal regulatory agencies, forest industry, and private organizations to protect environmental functions, and
- Provide pre-harvest planning and technical assistance to forest landowners and forestry professionals on implementation of BMPs.

5.1.4. Wildlife Management and Protection

South Carolina's forests face many threats, with changes in land-use being the leading cause of loss in forest cover. Forests, their ecosystems, and natural resources can be conserved through [conservation easements](#), sustainable forest management, and habitat management.

South Carolina is home to many rare species found only in this region and contains several global populations. South Carolina forests provide vital habitat to many imperiled plant and animal species. [Table 2](#) shows listed species (threatened, endangered, and at-risk) found in the forested habitats of South Carolina by LMP forest type. This table was created using the [South Carolina Department of Natural Resources' list of Rare, Threatened, and Endangered Species of South Carolina](#). Not all listed South Carolina species from the list are shown, only those with the potential to utilize some portion of forested habitat within their life

cycle. These habitats were then associated with each LMP forest type. Additional information on current listing status for each species can be found in the geodatabase.

Not all of the species listed below in Table 2 are state-or-federally listed threatened or endangered species, as some are designated as federally listed At-Risk species. These are species currently which are currently petitioned to the USFWS to be listed as either threatened or endangered but currently do not have a designation, as the USFWS is conducting species assessments to evaluate whether listing is needed.

Landowners with the potential for these At-Risk species on their property can discuss a Candidate Conservation Agreement with Assurances (CCAA) with USFWS should these species need to become listed in the future (<https://www.fws.gov/midwest/endangered/permits/enhancement/ccaa/index.html>). This CCAA is a formal agreement between the USFWS and one or more landowning parties to address the conservation needs of proposed candidate species prior to them receiving a listing designation. If proper conservation actions are taken prior to listing, it is hoped that there may not be the need for future listing.

Table 2 Rare animal species of South Carolina by LMP forest type

Common Name	Scientific Name	Longleaf Pine	Loblolly Pine	Shortleaf Pine/ Hardwood	Loblolly Pine- Hardwood	Upland hardwoods	Bottomland Hardwood	Carolina Bay	Tupelo-cypress mixed	Maritime Forests
Amphibians										
Broad-striped dwarf siren	Pseudobranchius striatus	x	x	x	x			x	x	
Chamberlain's dwarf salamander	Eurycea chamberlaini	x	x	x	x	x	x	x	x	
Frosted Flatwoods salamander	Ambystoma cingulatum	x	x	x	x			x	x	
Gopher frog	Lithobates capito	x	x	x				x		
Pine barrens treefrog	Hyla andersonii						x	x		
Webster's salamander	Plethodon websteri					x	x	x	x	
Birds										
American peregrine falcon	Falco peregrinus anatum	x	x	x	x	x	x	x	x	x
American swallow-tailed kite	Elanoides forficatus	x	x	x	x		x	x	x	
Bachman's warbler	Vermivora bachmanii						x	x	x	
Bald eagle	Haliaeetus leucocephalus						x	x	x	x
Bewick's wren	Thryomanes bewickii					x	x			x
Common ground-dove	Columbina passerina	x	x	x	x	x	x			x
Golden-winged warbler	Vermivora chrysoptera	x	x	x	x	x		x	x	x
Kirtland's warbler	Dendroica kirtlandii	x	x	x	x					
Red-cockaded woodpecker	Picoides borealis	x	x	x	x					
Wood stork	Mycteria americana						x	x	x	

Common Name	Scientific Name	Longleaf Pine	Loblolly Pine	Shortleaf Pine/ Hardwood	Loblolly Pine- Hardwood	Upland hardwoods	Bottomland Hardwood	Carolina Bay	Tupelo-cypress mixed	Maritime Forests
Fish										
Atlantic sturgeon	Acipenser oxyrinchus						✗			
Carolina pygmy sunfish	Elassoma boehlkei						✗		✗	
Robust redhorse	Moxostoma robustum						✗			
Shortnose sturgeon	Acipenser brevirostrum						✗			
Invertebrates										
Altamaha arc mussel	Alasmidonta arcula						✗			
Atlantic pigtoe	Fusconaia masoni						✗			
Broad River spiny crayfish	Cambarus spicatus						✗	✗	✗	
Brook floater	Alasmidonta varicosa						✗			
Brother spike	Elliptio fraterna						✗			
Calvert's emerald	Somatochlora calverti	✗	✗	✗	✗	✗	✗	✗	✗	
Carolina heelsplitter	Lasmigora decorata						✗			
Edmund's snaketail	Ophiogomphus edmundo						✗	✗	✗	
Frosted elfin	Callophrys irus	✗	✗	✗	✗					
Margaret's river cruiser	Macromia margarita						✗			
Mimic crayfish	Distocambarus carlsoni						✗	✗	✗	
Monarch butterfly	Danaus plexippus		✗	✗	✗	✗	✗	✗	✗	✗
Newberry burrowing crayfish	Distocambarus youngineri						✗	✗	✗	

Common Name	Scientific Name	Longleaf Pine	Loblolly Pine	Shortleaf Pine/ Hardwood	Loblolly Pine- Hardwood	Upland hardwoods	Bottomland Hardwood	Carolina Bay	Tupelo-cypress mixed	Maritime Forests
Septima's clubtail	Gomphus septima						✗	✗	✗	
Smokies needlety	Megaleuctra williamsae									
Mammals										
Eastern small-footed myotis	Myotis leibii	✗	✗	✗	✗	✗	✗	✗	✗	
Indiana myotis	Myotis sodalis	✗	✗	✗	✗	✗	✗	✗	✗	
Northern long-eared bat	Myotis septentrionalis	✗	✗	✗	✗	✗	✗	✗	✗	
Rafinesque's big-eared bat	Corynorhinus rafinesquii	✗	✗	✗	✗	✗	✗	✗	✗	
Tricolored bat	Perimyotis subflavus	✗	✗	✗	✗	✗		✗	✗	
Reptiles										
American alligator	Alligator mississippiensis						✗	✗	✗	
Eastern diamondback rattlesnake	Crotalus adamanteus	✗	✗	✗	✗	✗	✗			✗
Florida pine snake	Pituophis melanoleucus mugitus	✗	✗	✗	✗	✗				
Gopher tortoise	Gopherus polyphemus	✗	✗	✗	✗					
Southern coal skink	Eumeces anthracinus pluvialis						✗	✗	✗	
Southern hognose snake	Heterodon simus	✗	✗	✗	✗					✗
Spotted turtle	Clemmys guttata						✗	✗	✗	

5.1.4.1. Working Lands for Wildlife

One major initiative throughout the nation as well as the state of South Carolina is the program of Working Lands for Wildlife (WLFW). Established through NRCS and funded through EQIP, this program’s focus is to assist landowners in voluntary conservation efforts toward threatened species. NRCS provides financial and technical support to participants who voluntarily make certain improvements to their working lands in order to facilitate improvement of these species’ habitat. This initiative has proven successful in helping conserve more than 7.1 million acres of wildlife habitat nationwide and has benefitted species such as the greater sage-grouse and New England cottontail.

In South Carolina, a main target species of the WLFW program is the gopher tortoise. WLFW will assist landowners in the state to voluntarily create, restore, or enhance gopher tortoise habitat, and to improve habitat connectivity to allow the tortoise a greater range of habitat availability. NRCS funds will share the cost of conservation practices with landowners, as more than 80% of gopher tortoise habitat in the state is within private or corporate ownership (see Figure 8).

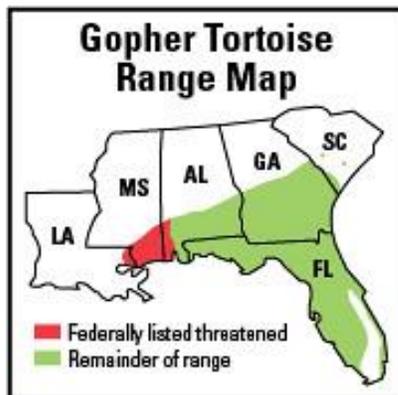


Figure 8 Historic and current gopher tortoise range, US Fish and Wildlife Service

Gopher tortoise habitat conservation falls within some of the core practices of WLFW, such as Restoration and Management of Rare and Declining Habitats and Upland Wildlife Habitat Management, as well as some of the supporting practices (Prescribed Burning, Forest Stand Improvement, Tree Shrub Site Preparation). Conservation of gopher tortoise habitat also falls within the scope of the Longleaf Pine Initiative (LLPI), which aims to focus resources on increasing the amount of longleaf pine habitat, as healthy longleaf pine habitat provides some of the best gopher tortoise habitat.

Another species of WLFW focus in South Carolina is the northern bobwhite (*Colinus virginianus*) through the Northern Bobwhite in Pine Savannas initiative. The northern bobwhite is typically an “edge” dweller, living where woodlands and crop fields intersect and taking cover under brush. While historic land use supported this species, modern land use changes have decreased the bobwhite’s population by more than 80% in the past 60 years. Now, bobwhite depend on early successional grassland, shrubby areas, and pine or oak savannas through the eastern United States. Through this WLFW program, NRCS is providing technical and financial assistance for landowners to make improvements to their land to attempt to create this necessary habitat, such as establishing field borders and buffer strips, thinning mature forests to create diverse, shrubby understory, and integrating native plants into pasture plantings. The habitat created for the northern

bobwhite is also beneficial for other woodland species, including turkeys, white-tailed deer, rabbits, gopher tortoises, bog turtles, and various types of songbirds.

A third species of focus is the red-cockaded woodpecker (*Leuconotopicus borealis*; RCW). [Audubon South Carolina](#) has made restoration of longleaf pine a priority in order to create additional habitat for the red-cockaded woodpecker. The goal of this program is to restore 661 acres of longleaf habitat at the Audubon's Silver Bluff facility and 230 acres at Francis Beidler Forest, while harvesting this wood carefully to leave appropriate habitat for the woodpeckers. It is hoped that RCW populations will readily stabilize once enough habitat is available. Restoration of this longleaf habitat will also benefit other species as well, including gopher tortoises, northern bobwhite, and various songbirds (pine warblers, brown-headed nuthatches, Bachman's sparrows, etc.).

5.1.5. Forest Ecological Restoration

Ecological restoration has been defined as the intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity, and sustainability ([Society of Ecological Restoration 2004](#)). These activities are performed on ecosystems that have been degraded, damaged, transformed, or destroyed as the result of direct or indirect anthropogenic activities ([Society of Ecological Restoration 2004](#)). The enhancement and restoration of native ecosystems is often a complex and iterative process that requires adaptation and engagement. Integrated natural resource management planning, including forest management, is essential for the successful attainment of ecosystem restoration and biodiversity objectives in many South Carolina ecosystems.

The [longleaf pine](#) and wiregrass community is a good restoration example. Many landowners in the [Southeastern Plains](#) and [Middle Atlantic Coastal Plain](#) ecoregions own land with deep, well-drained sandy soils that were historically populated by native longleaf pine communities. Since longleaf pine also can meet [aesthetic](#), [recreation](#), [legacy planning](#), and [economic](#) return objectives, many landowners are interested in its restoration. [The Longleaf Alliance](#) is working across the natural range of longleaf pine to restore the longleaf pine ecosystem. In South Carolina, three [Longleaf Implementation Teams](#) provide leadership at the local level for this effort. Through a combination of [active forest management activities](#), overstory and understory conditions can be restored to natural historic levels. Through frequent and consistent application of these activities, especially [prescribed fire](#), endemic (and often imperiled) fauna species can begin to repopulate the site. Some of these species, like the gopher tortoise (*Gopherus polyphemus*) that digs deep, winding burrows that support over 350 documented animal and insect species, are considered "keystone species" in this natural community (Ashton and Ashton 2004). Certain species can even be translocated to recolonize a site. For example, gopher tortoises and red-cockaded woodpeckers (*Picoides borealis*) can be relocated through various federal and state programs and partnerships, through the help of natural resource professionals. Restoration tools are further discussed within [silvicultural options](#) sections within all the [Common South Carolina Forest Types](#).

The different pine species are major components in a variety of natural communities. Longleaf pine was the dominant overstory component in forests frequently fire-maintained including both wet flatwoods and sandy uplands, and shortleaf pine was once the co-dominant overstory component of the Piedmont. These pines can be replanted as a step in restoring their respective natural communities.

Restoration among hardwoods can be accomplished in a variety of ways. Natural regeneration and hydrological restoration can be conducted to assist in ecological restoration of all the upland forest types. Additionally, small-scale artificial restoration can be implemented in the restoration of mixed floodplain, tupelo-cypress mixed, and cottonwood, sycamore, and birch forest types. Large-scale artificial regeneration of these forest types is usually unnecessary and economically unviable for most South Carolina landowners.

5.1.6. Non-Native and Invasive Species (NNIS) and Nuisance Species Management

There are many non-native invasive plant (NNIP) and animal (NNIA) species in the state of South Carolina. [Table 3](#) provides a list of the most common NNIS and nuisance species that impact forest management, using the South Carolina Exotic Pest Plant Council's (SC-EPPC) [Terrestrial Exotic Invasive Species List \(2014\)](#) as well as the SCFC's [Invasive Species of South Carolina Forests \(2019\)](#). Additionally, there are numerous native species which can function as nuisance species when their abundance and distribution impact historic and healthy forest conditions. For example, if not kept in check bermudagrass (*Cynodon* spp.), which is not on the above-mentioned lists, can be more disruptive to a habitat than such species as bahia grass and tall fescue that are on the list. Forest resource professionals can accurately assess which native species are serving in a nuisance capacity to inhibit the achievement of landscape objectives. Management and control of both NNIS and nuisance species is often most successful when it is integrative and adaptive (Miller et al 2015).

The SC-EPPC has identified Chinaberry (*Melia azedarach*), tree of heaven (*Alnus altissima*), Princess tree (*Paulownia tomentosa*), Chinese tallow tree (*Triadica sebifera*), Scotch broom (*Cytisus scoparius*), thorny-olive (*Elaeagnus pungens*), autumn-olive (*Elaeagnus umbellata*), shrub lespedeza (*Lespedeza bicolor*), Chinese privet (*Ligustrum sinense*), Japanese knotweed (*Polygonum cuspidatum*), trifoliolate orange (*Poncirus trifoliata*), English ivy (*Hedera helix*), Japanese climbing fern (*Lygodium japonicum*), Japanese honeysuckle (*Lonicera japonica*), kudzu (*Pueraria montana*), Cherokee rose (*Rosa laevigata*), Chinese wisteria (*Wisteria sinensis*), bigleaf periwinkle (*Vinca major*), cogongrass (*Imperata cylindrica*), Japanese stilt grass (*Microstegium vimineum*), Chinese silvergrass (*Miscanthus sinensis*), common reed (*Phragmites australis*), itchgrass (*Rottboellia cochinchinensis*), Johnson grass (*Sorghum halepense*), Chinese bush clover (*Lespedeza cuneate*), Asian spiderwort (*Murdannia keisak*), and tropical soda apple (*Solanum viarum*) as severe invasive threats to natural South Carolina communities. While all the severe species are important to recognize, cogongrass is a federally listed noxious weed and widely regarded as the worst invasive present in the southern United States. It is an invader of both natural and disturbed habitat, where its presence disrupts natural ecosystem functions, crowds out endemic shrub and grass species, and alters fire regimes and intensity (Bryson and Carter 1993).

While not yet drastically infected by cogongrass, South Carolina is on the advancing front of the infestation across the Southeast. As of 2009, cogongrass had been found in Pickens, Greenville, Anderson, Aiken, Williamsburg, Hampton, Allendale, Beaufort, and Charleston counties (South Carolina Statewide Forest Resource Assessment and Strategy 2010). Landowners in the vicinity of these cogongrass infestations are being made aware of the issues with cogongrass and the importance of its control. A cogongrass task force, led by [Clemson University Department of Plant Industry](#), is currently working to search for and control patches of cogongrass across the state.

Another major threat to natural communities in South Carolina is the emerald ash borer (EAB). This beetle, native to Asia, is responsible for the death or decline of tens of millions of ash trees in the United States in 13 states, ranging from New York to Indiana (USDA Program Aid 769). Larvae of this beetle feed on the tissue between the bark and sapwood of the tree, which disrupts the transport of nutrients within the tree and eventually kills it. The emerald ash borer was detected in South Carolina in 2017 and in surrounding states of Georgia and North Carolina in 2013 (EDDMaps 2019). The USDA has attempted to prevent spread on the EAB by quarantining areas where it is known to exist.

The ambrosia beetle-borne laurel wilt disease targets the *Lauraceae* family (red bay, sassafras, pond spice) and is decimating red bays in tupelo-cypress mixed and Carolina bay forest types and can only be slowed by actions such as limiting the transport of firewood. This insect/disease complex will likely eventually eliminate most red bay trees.

The hemlock woolly adelgid (*Adelges tsugae*) is another non-native pest known to affect Carolina and eastern hemlocks, which feeds by sucking sap from the base of foliage. Infected trees appear to have cotton on their foliage, hence the name, and usually succumb from carbohydrate loss 5-7 years post infestation. This insect has decimated the eastern hemlock of the Appalachian cove forests from Maine to Georgia. To preserve the most aesthetically/ecologically valuable trees, systemic insecticides are required to be periodically applied.

5.1.6.1. Prevention and Monitoring

Prevention is the key first step. Landowners and managers can limit the spread of NNIP's by minimizing ground disturbance activities and inspecting silvicultural and agricultural equipment for cleanliness prior to entering and departing the property. Spread of NNIA's can be minimized by avoiding the transport of these species from one property to another and through fencing. Despite strong prevention measures, birds, weather and other modes of spread will occur.

Monitoring can take place during routine work or recreational activities on the property. It is important to have species identification skills and resources to aid in monitoring. Early detection through monitoring allows for rapid, aggressive treatment before infestations become established and spread throughout the property.

5.1.6.2. Documentation and Planning

Documentation of new and existing infestations with GPS coordinates, GIS mapping, or location notes assist in the treatment and monitoring of infestations. Infestations can be marked with flagging, paint or other means. Documentation is also beneficial to insure all pesticides are approved by the [Environmental Protection Agency \(EPA\)](#) and applied, stored and disposed of in accordance with EPA-approved labels and by persons appropriately trained, licensed, and supervised.

NNIS and nuisance species management plans can be developed to treat minor and major infestations. Integrated pest management is adaptive, aggressive and may include the following:

- Infestation occurrence and treatment documentation
 - Good record keeping
 - GIS mapping of new and existing
- Treatment plan and schedule
 - Frequency, seasonality and methods
 - Combination of treatment methods typically most effective
- Monitoring plan and schedule
 - Frequency and locations
- Adjust retreatment methods and monitoring as needed
- Repeat this cycle until control is achieved

5.1.6.3. NNIP and nuisance plant treatment methods:

- Chemical
 - Ground: broadcast or isolated treatment
 - Foliar, cut stump, hack-n-squirt, injection, basal bark, soil spot (grid)
 - Backpack and hand sprayers; ATV, farm tractor, skidder-mounted sprayers
 - Aerial: broadcast by helicopter (broadcast)
- Mechanical: broadcast or isolated
 - Hand-pull, chop, mow, mulch
- Prescribed fire (broadcast)
 - Dormant or growing season
- Additional information can be found through Miller et al 2015 and online at https://www.srs.fs.fed.us/pubs/gtr/gtr_srs131.pdf

5.1.6.4. NNIA treatment methods:

- Feral hogs
 - Do not transport onto property and prohibit hunting lessees from doing so
 - Property boundary fencing
 - Promote year-round aggressive hunting and trapping
 - Licensed contract trappers available
 - Careful game species food plot crop selection
 - Consultation and additional information through [USDA Wildlife Services](#)

5.1.6.5. Nuisance animal treatment methods:

- White-tailed deer
 - Do not transport onto property and prohibit hunting lessees from doing so
 - Modify and increase deer harvest to control population abundance and sex ratios
 - Maintain property boundary fencing
 - Install exclusionary fencing around young plantations and/or regeneration areas

- Licensed contract trappers available
- Practice time logging activities and use uneven aged stands to provide continual availability of browse and forage options.
- Beaver
 - Do not transport onto property and prohibit hunting lessees from doing so
 - Monitor all water sources and potential impoundment locations frequently for activity
 - Promote year-round aggressive hunting and trapping
 - Licensed contract trappers available
 - Destroy any dams or impoundments in conjunction with trapping and harvesting efforts
 - Consultation and additional information through [USDA APHIS Wildlife Services](#)

Table 3 Common South Carolina non-native invasive, plant (upland) and animal species list, divided by threat category and species type

Common Name	Scientific Name	Threat Level
Trees		
Tree of heaven	<i>Ailanthus altissima</i>	Severe Threat
Chinaberry	<i>Melia azedarach</i>	Severe Threat
Princess Tree/Royal Paulownia	<i>Paulownia tomentosa</i>	Severe Threat
Chinese Tallow Tree	<i>Triadica sebifera</i>	Severe Threat
Mimosa, Silktree	<i>Albizia julibrissin</i>	Significant Threat
Paper Mulberry	<i>Broussonetia papyrifera</i>	Significant Threat
Chinese Parasol Tree	<i>Firmiana simplex</i>	Significant Threat
White Mulberry	<i>Morus alba</i>	Significant Threat
White Poplar	<i>Populus alba</i>	Significant Threat
Callery Pear (Bradford Pear)	<i>Pyrus calleryana</i>	Significant Threat
Camphortree	<i>Cinnamomum camphora</i>	Emerging Threat
Shrubs		
Scotch Broom, English Broom	<i>Cytisus scoparius</i>	Severe Threat
Thorny-olive	<i>Elaeagnus pungens</i>	Severe Threat
Autumn-olive	<i>Elaeagnus umbellata</i>	Severe Threat
Two Color Bush Clover, Shrub Lespedeza	<i>Lespedeza bicolor</i>	Severe Threat
Chinese Privet	<i>Ligustrum sinense</i>	Severe Threat
Japanese Knotweed, Fleeceflower, Mexican Bamboo	<i>Polygonum cuspidatum (Fallopia japonicum)</i>	Severe Threat

Common Name	Scientific Name	Threat Level
Trifoliolate Orange, Hardy Orange	<i>Poncirus trifoliata</i>	Severe Threat
Japanese Privet, Waxy-leaf Privet	<i>Ligustrum japonicum</i>	Significant Threat
Nandina, Sacred Bamboo	<i>Nandina domestica</i>	Significant Threat
Multiflora Rose	<i>Rosa multiflora</i>	Significant Threat
Glossy, Tall Glossy Privet	<i>Ligustrum lucidum</i>	Emerging Threat
European Privet	<i>Ligustrum vulgare</i>	Emerging Threat
Sweet Breath of Spring, January Jasmine	<i>Lonicera fragrantissima</i>	Emerging Threat
Macartney Rose	<i>Rosa bracteata</i>	Emerging Threat
Jerusalem Cherry	<i>Solanum pseudocapsicum</i>	Emerging Threat
Meadowsweet	<i>Spiraea japonica</i>	Emerging Threat
Saltcedar, Tamarisk, French Tamarisk	<i>Tamarix ramosissima, T. parviflora, T. gallica, T. africana</i>	Emerging Threat
Beach Vitex, Chasteberry, Roundleaf Chastetree	<i>Vitex rotundifolia</i>	Emerging Threat
Vines		
English Ivy	<i>Hedera helix</i>	Severe Threat
Japanese Climbing Fern	<i>Lygodium japonicum</i>	Severe Threat
Japanese Honeysuckle	<i>Lonicera japonica</i>	Severe Threat
Kudzu	<i>Pueraria montana</i>	Severe Threat
Cherokee Rose	<i>Rosa laevigata</i>	Severe Threat
Chinese Wisteria	<i>Wisteria sinensis</i>	Severe Threat
Bigleaf Periwinkle	<i>Vinca major</i>	Severe Threat
Common Periwinkle	<i>Vinca minor</i>	Significant Threat
Chinese yam	<i>Dioscorea polystachya (D. oppositifolia)</i>	Significant Threat
Asian/Oriental Bittersweet	<i>Celastrus orbiculatus</i>	Significant Threat
Sweet Autumn Virgin's Bower, Yam-leaved clematis	<i>Clematis terniflora</i>	Significant Threat
Purple Crownvetch	<i>Securigera varia (Coronilla varia)</i>	Emerging Threat
Asian/Japanese Wisteria	<i>Wisteria floribunda</i>	Emerging Threat
Grasses		
Cogongrass	<i>Imperata cylindrica</i>	Severe Threat
Nepalese Browntop, Japanese Stilt Grass	<i>Microstegium vimineum</i>	Severe Threat
Chinese Silvergrass	<i>Miscanthus sinensis</i>	Severe Threat
Common Reed, Phragmites	<i>Phragmites australis ssp. australis</i>	Severe Threat

Common Name	Scientific Name	Threat Level
Itchgrass	<i>Rottboellia cochinchinensis</i>	Severe Threat
Johnson Grass	<i>Sorghum halepense</i>	Severe Threat
Weeping Love Grass	<i>Eragrostis curvula</i>	Significant Threat
Tall Fescue	<i>Festuca arundinacea</i>	Significant Threat
Dallis Grass, Dallas grass	<i>Paspalum dilatatum</i>	Significant Threat
Bahia Grass	<i>Paspalum notatum</i>	Significant Threat
Vasey's Grass, Vaseygrass	<i>Paspalum urvillei</i>	Significant Threat
Torpedo Grass, Creeping Panic, Couch panicum	<i>Panicum repens</i>	Significant Threat
Golden Bamboo, Fishpole Bamboo	<i>Phyllostachys aurea</i>	Significant Threat
Giant Reed	<i>Arundo donax</i>	Significant Threat
Herbs		
Sericea, Chinese Bush Clover	<i>Lespedeza cuneata</i>	Severe Threat
Wart Removing Herb, Marsh Dewflower, Aneilema, Asian Spiderwort	<i>Murdannia keisak</i>	Severe Threat
Tropical Soda Apple	<i>Solanum viarum</i>	Severe Threat
Nodding Thistle, Nodding Plumeless Thistle, Musk Thistle	<i>Carduus nutans</i>	Significant Threat
Bull Thistle	<i>Cirsium vulgare</i>	Significant Threat
Showy Rattlebox	<i>Crotalaria spectabilis</i>	Significant Threat
Queen Anne's Lace/Wild Carrot	<i>Daucus carota</i>	Significant Threat
Rattlebox, Scarlet Wisteria Tree, Spanish Gold, Purple or Red Sesbania	<i>Sesbania punicea</i>	Significant Threat
Fig Buttercup, Lesser Ctenandine	<i>Ficaria verna</i>	Emerging Threat
Giant Hogweed	<i>Heracleum mantegazzianum</i>	N/A
Insects		
Emerald Ash Borer	<i>Agrilus planipennis</i>	N/A
Spotted lanternfly	<i>Lycorma delicatula</i>	N/A
Gypsy moth	<i>Lymantria dispar</i>	N/A

5.1.6.6. Biological Control

Per the USDA Forest Service's Forest Health Technology and Enterprise Team ([FHTET](#)), a biological control is "the reduction of an organism's population density through use of its natural enemies". The [FHTET](#) recognizes biological control as being one of the most effective and cost-efficient long-term approaches for managing widespread non-native invasive species infestations. This involves utilizing natural enemies (parasites, predators, herbivores, and pathogens) to reduce the population of hosts, whose abundance influences the population levels of natural enemies (USDA-FS 2016). Biological control can be used as a component within a comprehensive Integrated Pest Management program (van Lenteren 2012). For example, some areas under this LMP have utilized rotational grazing of goats to control kudzu infestations.

In some scenarios, biological control may also be used for native vegetation management such as utilizing fenced goats as an alternative to herbicide, mechanical or prescribed fire treatments (USDA-NRCS 2015). However, the use of "prescribed grazing" in these scenarios can be less selective from a species standpoint, impacting both desirable and undesirable species (USDA-NRCS 2015). Despite good intentions and rigorous governmental regulatory environmental risk assessments along with standards and guidelines for the import, export, shipment, evaluation and release of biological controls, it is still possible for these species themselves to become ecologically problematic in forest settings (van Lenteren 2012).

5.1.7. Supporting Military Bases

An important consideration regarding ecosystem conservation within South Carolina, especially with the military installations of Fort Jackson and Shaw Air Force Base present within the state, is the [Readiness and Environmental Protection Integration](#) (REPI) program instituted through the Department of Defense (DoD). The REPI is a key tool for combating developmental encroachment that can hamper or restrict military training, testing, and operations. These actions are protected through the REPI program by helping remove or avoid land-use conflicts affecting military bases and appropriately addressing regulatory restrictions.

Encroachment is a factor that limits military readiness, and can come in the forms of competition for land, airspace, or waterfront access, as well as the development of nearby land. Development near military bases can decrease their capacity for readiness through a variety of factors, such as light pollution affecting night vision training, complaints from nearby residents affecting the timing of military exercises, or development of land near bases causing endangered species to move onto military land, resulting in increased training/operation restrictions. A main tool of the REPI Program to combat encroachment is to use buffer partnerships among military services, private conservation groups, and state and local governments. These partnerships benefit both entities through sharing the cost of easement acquisitions or working to preserve compatible land uses and natural habitats located near military installations or ranges.

The REPI Program can also help to benefit the environment through its actions. Some of these beneficial methods include conservation of land near military bases and ranges, protecting working lands (farms, forests, ranches, etc), preserving aquatic habitat, and protecting endangered species.

5.2. Landowner Objectives

The following common landowner objectives considered under this LMP were derived from the stakeholder group comprised of various forest resource professionals and governmental agencies within South Carolina

and the South Carolina Forest Stewardship Program. A general description of each potential landowner objective is discussed relative to its application towards forest management. Each landowner objective is also discussed relative to its application within each forest type in the [Common South Carolina Forest Types Section](#).

5.2.1. Forest Health Management

Maintaining and promoting forest health is a major landowner concern and objective. Many unengaged landowners not actively managing their forests initially contact a [forest resource professional](#) regarding forest health issues.

Various [cost share programs](#), grants and services aid South Carolina landowners in taking preventative measures to avoid devastating outbreaks and infestations. [Silvicultural options](#) such as timber harvest, prescribed burning and non-native invasive species treatments are also available to landowners to improve forest health.

[Non-native invasive species](#) such as cogon grass and feral hogs can cause major ecological and economic damage to South Carolina forests. Native forest pests such as southern pine beetle are always a potential threat to our forests. Several native diseases such as fusiform rust and pitch canker among others and non-native diseases such as oak and laurel wilt also cause damage across multiple forest types. These pests and diseases as well as other known to affect species within South Carolina forests will be addressed below by species type for pines and by hardwood grouping. Additional information concerning the multiple invasive pests affecting South Carolina forests can be found through the [SCFC Forest Health webpage](#), while information concerning the various diseases affecting South Carolina forests can be found through the [Threats to South Carolina's Forests](#) booklet available from the SC Forestry Commission. While the following sections provide a short background of major issues, the two referenced sources are the best resources for additional information.

5.2.1.1. Pine Forest Health Management

The most destructive insect pests to loblolly pine are southern pine beetle (SPB), Ips, and black turpentine beetle (BTB). Loblolly is the preferred host for SPB. It is usually not a major issue in younger, well-managed stands. However, damage can be severe in overstocked and senescent stands, especially if offsite or other stressors occur (i.e. drought, lightning strikes, fire stress). Once a severe outbreak occurs, it can spread to adjacent, well-managed, younger stands. Outbreaks are cyclical and range from a few spots across a stand to hundreds of acres, with the last occurrence of this in South Carolina coming during 2000-03. Ips and BTB are less aggressive and cause damage on an annual basis, usually following summer drought, and their attacks rarely exceed more than 3/10th of an acre. SPB and Ips both contain a lethal blue stain fungus that clogs the tree's water conducting tissue, making most attacks along the trunk lethal. BTB does not have the lethal blue stain fungus and pines can survive after being attacked.

Maintaining health and vigor among your pines is the most economical way of reducing loss from bark beetles. Pines exhibiting these qualities will have plenty room and resources to grow, have 33-40 percent crowns (crown length/total length), and are free of disease along their trunks. Foresters sustain these attributes in pine plantations by removing pines that do not exhibit these qualities while retaining pines that do.

Suppressing understory competition can be just as effective at increasing pine health and vigor as thinning. Foresters control this competition in pine plantations through prescribed burns, herbicides, or cutting by machine or hand. All of the above ensures most of the resources are available for the pines that can most utilize them, and these same pines will then usually have enough internal water pressure/turgor to drown attacking beetles, even during times of environmental stress.

Pitch canker and fusiform rust are fungal diseases affecting pines and are most problematic when affecting the main trunk, which disrupts the uptake of water and nutrients and causes increased susceptibility to a bark beetle attack. Pitch canker is known for its heavy resin exudation and affects all pine species throughout South Carolina. Fusiform rust is known for its galls that create a weak spot along the trunk, which continues to grow with the tree over time and produces orange spores every spring. Resistance to both diseases continues to be developed in planting stock with much success

The most detrimental disease to shortleaf pine is littleleaf disease. Infection is high on poorly drained sites, on poor soils and following root damage and drought. However, due to severe erosion resulting from past farming practices in South Carolina's Piedmont, these at-risk soils are now ubiquitous. Littleleaf mostly occurs in 30-50-year-old stands and seldom in stands less than 20 years old. It can result in slow growth and high mortality. Proper shortleaf pine site selection and appropriately-timed thinning or clearcutting can reduce chances of infection with littleleaf.

Tip moths, pine saw flies, and pales and pitch-eating weevils can be problematic in young stands. Tip moths damage the terminal shoots on young pine seedlings, which can result in loss of growth and deformity of the tree if severe. Pine sawflies are a major defoliant of young pine saplings, capable of causing the complete loss of foliage on small trees. Loblolly pine sawfly also attacks shortleaf pine. Pales and pitch-eating weevils usually cause issues in newly-planted stands if planted too soon after harvest. Reforestation of stands harvested after July should not be done the next planting season or, if done, should use seedlings that have been treated with insecticides.

Annosus root rot is a fungal disease associated with all pines growing in sandy soils that prevents the normal uptake of water and nutrients. Its spores will land on freshly cut stump surfaces, inoculate, and then spread to living pines through existing root grafts, making it an issue with recently thinned pines growing on sandy soils. Infected pines usually die from attacking beetles rather than solely from the disease, which makes Annosus largely overlooked. Peak tree loss seems to occur during 3-6 years post thinning and the disease subsides 8-10 years post thinning. The disease is least active in South Carolina during the summer months, June-August, and most tree loss occurs within pine stands first-thinned during the winter months located on sandy soils that were former Ag sites, pasture or field. Old ag sites with sandy, well-drained soils with a low water table and a hardpan missing, or deeper than 12", are considered high hazard sites, which placed this disease in the limelight during the early 2000s when CRP stands were being first-thinned. Prevention is the key with annosus root rot. If conducting a first thinning on high hazard sites, consider thinning during the summer months or treating the stumps within 24hrs of felling with a Borax compound. Minimizing stand entries by thinning heavier (60-70 BA) should also be considered. If pine loss occurs on sandy soils and 2-4 years post thinning, suspect annosus root rot. Once confirmed in a stand, it is generally recommended to wait until the disease has become inactive (8-10 years post thinning) before conducting the next thinning.

As previously mentioned, longleaf is the most resilient of South Carolina pine species, as they are not typically affected as severely by Ips, SPB, or BTB. The most detrimental disease is brown spot needle blight which is only an issue during seedling stage in planted stands. It is not an issue once rapid vertical growth commences and can be mitigated by prescribed burning grass stage seedlings starting around the second year, post-establishment. Pitch canker and fusiform are not a major concern with longleaf and issues are localized, although the latter can cause excessive damage on old field sites.

Pales weevil, feral hogs and livestock can cause damage to seedlings of longleaf pine. Lightning and subsequent southern pine beetle and Ips beetles causes severe damage in mature stands, where otherwise these are not a major concern. Southern pine beetle is not a major concern in younger, well managed longleaf stands. It can become a concern in offsite, overstocked and senescent stands, especially during drought conditions and following fire stress. The first year of establishment is most vulnerable for longleaf, particularly during droughts or the typically dry months of spring.

Loblolly and shortleaf pine cannot tolerate prescribed fire until the bark thickens and they reach about 10-15 feet tall (depending on fuel load). They are susceptible to crown and inner bark scorch, especially in younger stands. Longleaf is naturally fire-resistant at this early life stage.

Despite all of these potential insect and disease issues, with appropriate seedling and site selection and release and thinning regimes, pines generally have minimal issues following successful establishment.

If any of the above diseases or pests are suspected, SCFC should be contacted for a consultation.

5.2.1.2. Hardwood Forest Health Management

Loblolly pine-hardwood mixed, shortleaf pine-hardwood mixed, upland hardwoods, tupelo-cypress mixed, Carolina bay, and maritime forests are generally not as intensively managed as pine forests and as such mortality caused by native diseases and insects are typically not a major concern. Common issues with hardwood forest types are insect defoliators, butt rot and heart rot fungi, and oak wilt.

The most common defoliators for hardwoods are canker worms and forest tent caterpillars. Both occur in early spring, just after leaf formation, and generally just cause a loss of growth for that growing season. Mortality sometimes occurs on the weakest trees when defoliations have occurred in consecutive years. Canker worms are usually found with the Piedmont and rarely impact more than a few acres. Forest tent caterpillars are usually found in the bottomland hardwood forests located in the ecoregions east of the Piedmont and can defoliate thousands of acres.

Butt rot and heart rot fungi enter a hardwood tree from deep basal wounds caused by fire or logging. These diseases grow undetected for many years, eventually degrading the tree's use for lumber. During logging operations, it is imperative to minimize damage to residual hardwood trees, and if conducting a prescribed burn within an upland hardwood stand, understand the risks and try to minimize damage to trunks and root flares by not burning when it is too hot and dry. Prescribed burns are more likely to damage hardwoods when pine litter, which increases fire intensity, is adjacent to them, such as the case with loblolly or shortleaf pine-hardwood mixed stands.

Oak wilt is primarily a fungal disease of red oaks (especially water and willow oaks) growing on sandy soils located in the Southeastern Plains. Infected trees will eventually have their water conducting tissues blocked, causing their leaves to abruptly wilt soon after leaf formation in early spring. The fungal disease may start from a wound caused by an insect or equipment, but once started, it likely transmits from tree to tree via root grafts. Fungal mats located under the bark of infected tree are also inoculum sources used by insects to transmit the disease. Suspect oak wilt if young, healthy red oaks are suddenly dying. Sanitation and severing root grafts with a vibratory plow are two methods used for its control.

Major native insect and disease damage is species and site specific and should be evaluated by a forester. For example, the ambrosia beetle-borne laurel wilt disease is decimating red bays in tupelo-cypress mixed and Carolina bay forest types. It can only be slowed by actions such as limiting transport of firewood. This disease will likely eventually eliminate most red bay trees. The hemlock woolly adelgid (*Adelges tsugae*) is another pest known to affect hardwoods (hemlocks). Eastern hemlock is the most susceptible to these pests, which feed by sucking sap from these species.

If any of the above diseases or pests are suspected, contact the SCFC for a consultation.

5.2.2. Conservation

For this LMP, conservation is defined as the process of maintaining a natural resource (e.g. forested ecosystem) for perpetual use. This definition inherently associates conservation with the proper use of ecological processes to maintain the forested ecosystem. The term conservation is generally credited to Gifford Pinchot, who served as President Teddy Roosevelt's head of the US Forest Service in the early 20th century (Trefethen 1975).

Some landowners have a conservation objective because they would like to see their forest ownership remain intact and capable of being passed down from generation to generation. Landowners with a conservation objective may also utilize other consumptive use objectives like revenue generation or hunting and fishing recreation.

Conservation and legacy planning are both founded upon the desire to ensure future use of a natural resource. Many landowners seek to achieve a balance between conservation and legacy planning objectives by utilizing silvicultural tools to mimic ecological processes (conservation) and restricting human activities outside their interests (legacy planning).

All forest types can be managed in a conservation-oriented manner. This can be accomplished using multiple-use management by balancing utilization and protection of timber, wildlife, rare plants, recreation and hydrology. Pine forests are fire dependent and require frequent application of prescribed fire at minimum for ecological maintenance; hardwood forest types do not require these fire-related management techniques, although some may benefit from these management techniques.

5.2.3. Economic Return

Sources of forest-based revenue in South Carolina are diverse and can be derived from each forest type. Some landowners choose to balance revenue with other objectives while for others it is their primary objective and livelihood.

5.2.3.1. Timber Management

Landowners have strong, diverse timber markets in South Carolina, allowing them to manage on short or long rotations for pine, hardwood and cypress products. This flexibility and economic potential in timber markets allows for restoration, revenue and investment. A current timber price report by quarter is available through the South Carolina Forestry Commission (<https://www.trees.sc.gov/forest/mprice.htm>).

Economy of scale plays a large role in timber management, and landowners must always take that in consideration when managing their forest lands. Factors affecting economies of scale are stand acreage; forest product type, size, and quality; and distance from a related forest product mill. Loggers incur costs whenever they move their equipment from one tract to the other, which makes larger tracts/stands with high value forest products closer to the mill more attractive. As a result, landowners should consider having forested stands no less than 20 acres in size, and landowners with smaller stands may need to do timber management in conjunction with another stand or with an adjacent landowner.

The above scenario becomes apparent in the upper Piedmont, where parcel sizes are generally smaller and farther away from most pulpwood mills. Landowners in this region are encouraged to plant above-average, genetically available pines on a farther spacing (9' X 10') than conventional (7-8' X 10') and conduct the first-thinning at a later date, which increases the availability of higher value product classes and the likelihood of the stand being thinned.

On the contrary, landowners located in the lower Piedmont and east of the Piedmont should consider taking advantage of available pulpwood markets and plant pines on a conventional spacing and thin as soon as they can. This is especially true for pulpwood-sized stands located on well-drained soils in the upper Southeastern Plains. During wet winters, these stands usually demand the highest pulpwood prices and are known as "all-weather-tracts."

Timber sales can either be done as a per unit basis or as a lump sum sale. Most thinnings are sold as a per unit (ton) basis, where the contract states a price per ton for each product removed. Lump sum sales usually involve final harvests or stands where the take trees have been marked.

There are many tools available to help with timber management including thinning, clearcutting and natural and artificial regeneration. Landowners can utilize uneven-aged management with longleaf pine and hardwoods and even-aged management with other pine species and cypress. With its ease of implementation, most forest types are managed as even-aged, with uneven-aged management usually limited to aesthetically sensitive areas or areas facing other constraints such as threatened and endangered species.

5.2.3.2. Non-Timber Forest Products

Forestland owners have many revenue sources aside from timber products. South Carolina's forests provide various non-timber forest products (NTFP). These are wide-ranging and include pine straw, honey, silvopasture, saw palmetto drupes, ginseng, and cypress knee sales. These markets can provide landowners with revenue between timber harvests or may be the main source of revenue generation from their forests (Chamberlain and Predny 2003).

5.2.3.3. Non-Forest Associated Land Uses

Some revenue-generating options should be considered with caution due to disadvantages associated with them. For example, the following land uses may prevent or cause loss of ATFS certification.

- Eco-tourism through opening private land to public access for a fee.
 - Canoe, kayak and boat rentals and tours along the many scenic waterways adjacent to South Carolina's forests.
 - Hunting leases
- Mining for aggregate materials
 - Sand, clay, stone, and gravel
 - Need local permitting
 - Will alter local hydrology and cause ecological impacts
- Mineral and gas leases
- Oil, gas, and electric Right-of-Way and easement leases
 - Can be positive or negative, depending on how the land is maintained
- Timberland real estate
 - May involve land development or forestry/agriculture
 - Can conflict with ATFS and FSP Standards

5.2.3.4. Timber Tax

No matter the reason for deriving revenue from one's forest, one issue that must be faced by all landowners regarding economic return is timber taxes. The timber tax code is extensive and can be confusing for landowners whose goal is to simply manage property for periodic financial gain. These taxes are dependent on a variety of factors and situations, with some of the more frequently encountered described briefly below (Wang 2018).

5.2.3.4.1. Timber Property Types

In calculating timber taxes, it is first necessary to determine the type of property in question, as this governs how taxes are determined. Properties may be classified as personal-use (lands used for personal enjoyment instead of profit), investment property (lands used mainly for the generation of profit from growing timber or appreciating assets), or business property (lands that experience regular, active, and continuous timber activities to make a profit). These varying property types are impacted differently by taxes; for example, if the land is personal use and not engaged for profit, losses to trees are not tax deductible.

5.2.3.4.2. Deductions of Timber Expenses and Taxes

Timber expense and tax deductions are calculated differently depending on the property type in question. For timber on a business property, if one is materially participating in the business, expenses such as forester/accountant/attorney fees, precommercial thinning, firebreak maintenance, vegetation/competition control, insect/disease/fire control, or depreciation from equipment used are all fully deductible through Form 1040. If the property is an investment, however, starting in the 2018-2025

cycle timber expenses are no longer deductible on an annual basis and can be applied as “Carrying Charges” to the timber basis and deducted upon timber sales. State and local property taxes on these investment properties are still deductible on an annual basis using a Schedule A, or can be applied as carrying charges as well. Also, South Carolina has an [agricultural use tax exemption](#) for farmers, foresters, or other agricultural land users.

5.2.3.4.3. Timber Basis and Depletion Deduction

Timber basis is the amount one paid for the timber when purchasing the property. If the property was inherited, the timber basis is the timber’s fair market value on the previous owner’s date of death. This original timber basis from the two above scenarios can change as capital improvements are made to the land or as depletion, amortization, or depreciation are deducted from the timber basis (Megalos et al 2016). Certain timber management and operation expenses may be capitalized as “Carrying Charges” to the timber basis and recovered upon timber sales. Depletion deductions are deductions against the timber basis upon timber sale. These deductions reflect the removal of timber from the property and provide a way to calculate the timber basis that remains on the property. Another type of depletion could be the loss of timber to a casualty event such as hurricane, fire, earthquake, tornado, etc. This type of depletion is also tax deductible and is the lesser of the following two calculations: 1) difference of the fair market value (FMV) of the timber immediately before and after the casualty, or 2) difference of the adjusted basis (less any insurance proceeds or salvage value) before and after the casualty.

5.2.3.4.4. Reforestation Costs

Reforestation costs may be tax deductible as well. Landowners can deduct up to \$10,000 per year for land designated as qualified timber property (QTP). If it costs more than \$10,000 per year for reforestation, the cost may be deducted over the span of 84 months (amortized). Trusts, however, are only eligible to use the amortization method. The amount deducted cannot also be expensed as a timber basis or vice versa.

5.2.3.4.5. Cost-Share Payments

Cost-share programs are of great value to many landowners, and some applications of cost-share can be excluded from your income. Part or all of a qualified cost-share payment received can be excluded from income if it was used for capital expenditure (purchases of land, timber, or equipment, expenditures for bridge or road construction, or expenses for tree planting or seeding; Jones and Jacobson 2000). Qualified federal programs that accept income inclusion are the [Forest Health Protection Program](#), [Conservation Reserve Program](#), [Conservation Stewardship Program](#), and [Environmental Quality Incentives Program](#). There are also multiple state programs that qualify for exclusion, depending on the state. SCFC’s [Forest Renewal Program \(FRP\)](#) and [Southern Pine Beetle Program \(SPB\)](#) both qualify for this exclusion. The excludable amount is calculated as the present value of which is greater: \$2.50 per acre or 10 percent of the average annual income from affected areas over the previous 3 years. The excluded amount cannot also be deducted from income or expensed as a timber basis; e.g., if the total costs were \$10,000 and the excluded cost share payments were \$4,000, the amount deducted from income or expensed as a timber basis should be \$6,000.

5.2.3.5. Long-Term Investment

Another way to generate economic return from timberland is to use the land as a long-term investment. In the past, the economic return of treating timberland as an investment has compared favorably with stocks while providing more financial stability (King 2019). The U.S. timber investment performance is monitored by the [National Council of Real Estate Investment Fiduciaries \(NCREIF\) Timberland Index](#). Returns through timber investment as monitored by this index have shown that, over the previous 20 years, timberland-generated profits are nearly equal to those gained by equity investments through the S&P 500 while encountering less than half of the volatility.

There are a few main reasons that a landowner may choose to use their timberland as an investment. First, timberland value tends to rise with inflation, thereby hedging the risk of devaluation by inflation and keeping timber prices stable relative to the index. Secondly, trees continue to grow in volume over time, as well as value, completely independent of the current economic state. Therefore, if the timber market is currently in an unfavorable state, the trees can remain in the ground to retain their value until the prices become more favorable. However, postponing the first thinning of a young pine stand can have negative effects on the stand's long-term growth and IRR. A third more intrinsic value of timberland as an investment is that the land can be enjoyed recreationally while waiting to make a profit. This "bonus" can even be as valuable to landowners as the profit they will eventually make from the timberland investment.

Regardless of the reasons for using timberland as a long-term investment, the property must be managed properly in order to produce the most and best-quality timber possible. A forester can assist in the management of timberland through a multitude of forest and [silvicultural](#) management techniques, as discussed in [Section 8](#).

5.2.4. Wildlife Management and Protection

South Carolina is rich in both game and non-game wildlife species. Many landowners are interested in managing, conserving and protecting these species and their habitat. Simply [conserving](#) forestland is a form of wildlife habitat protection. Some landowners wish to take a more active wildlife management role by maintaining, enhancing and restoring wildlife habitat and its components: food, cover, water and space.

Private lands in the state of South Carolina provide valuable habitat to imperiled species such as red-cockaded woodpecker, Northern long-eared bat, gopher tortoise, and frosted flatwoods salamander. Many silvicultural tools are available to maintain, enhance and restore habitat for game and non-game species including [prescribed fire](#), [timber harvests](#), groundcover restoration, food plots and wildlife openings.

The [SC BMPs for Forestry](#) manual compiles strategies and considerations for managing and protecting these species and their habitat during silvicultural operations. The natural resource professional and landowner can try in the field to locate and protect any imperiled species and their habitat prior to some silvicultural activities. The [LMP Geodatabase and associated resources](#) can be used to locate any known imperiled species occurrences on a property. Although not an exhaustive list, if imperiled species and/or their habitats are located, the following protection measures can be used:

- Limited mechanical entry
- Increased management activity (prescribed fire, thinning, etc.)

- Restricted pesticide use
- Residual tree maintenance
- Buffer zone establishment and maintenance
- Hunting or fishing limitations
- Signage or marking of the habitat area
- Communicate sensitive habitat/species locations in contracts; discuss with contractors

South Carolina has some of the best hunting opportunities in the Southeast in terms of acreage and game quality and quantity. Hunting and revenue from hunting leases are particularly popular landowner management objectives. White-tailed deer, wild turkey, bobwhite quail, duck and feral hog are commonly hunted and managed. Wildlife conservation practices may include managing healthy game species populations through hunting programs such as [Quality Deer Management](#) and hunt leases. Landowners often lease their land to hunting clubs or individuals as a form of revenue. This revenue can be used to improve and protect habitat.

5.2.4.1. Pine Forest Wildlife Habitat Management and Protection

The pine forest types, and their associated natural communities, provide excellent wildlife habitat management and protection opportunities. Many game and imperiled species can be found within pine forests. Game species are more commonly actively managed on private lands while non-game species are managed to a lesser extent.

Hunting is a common wildlife management objective in the pine forest types, particularly for wild turkey, bobwhite quail, and white-tailed deer. These species benefit from a frequently fire-maintained open, grassy groundcover, with low shrubs and little to no midstory. They also prefer a relatively lower overstory density, which helps provide more sunlight to the desired groundcover. Hunting leases are used to manage healthy game populations while also generating revenue to help pay for pine management activities such as prescribed fire.

Pine habitat objectives can be met with various [silvicultural options](#). For example, thinning planted pine stands to a lower overstory density more favorable to wildlife or creating small [clearcuts](#) for wildlife openings to diversify habitat and create edge both ensure adequate wildlife habitat. Many game and non-game species of pine forests will benefit from these activities including white-tailed deer, wild turkey, bobwhite quail, gopher tortoise, fox squirrel and red cockaded woodpecker.

Wildlife habitat protection objectives can be met through [legacy](#) planning practices. The more hands-off preservation approach can be used to protect non-game species in healthy, fully functioning pine forests. However, active management with [prescribed fire](#) at minimum is required to maintain this forest type and its habitat components.

5.2.4.2. Hardwood Forest Wildlife Habitat Management and Protection

The hardwood forest types, and their associated natural communities, provide excellent wildlife habitat management and protection opportunities. Many game and imperiled species utilize hardwood forest types

for mast, browse, or cover throughout the year. Game species are actively managed on private lands while non-game species are managed to a lesser extent.

Hunting is a common wildlife management objective in the hardwood forest types, particularly for white-tailed deer, wild turkey, feral hogs, and gray squirrel. Hunting leases are used to manage healthy game populations while also generating revenue to help pay for management activities such as NNIS.

Hardwood habitat objectives can be met with various silvicultural tools. For example, creating small group selection clearcuts for wildlife openings to diversify habitat and create edge. Many game and non-game species will benefit from these activities including white-tailed deer, wild turkey, and within more hydric environments, waterfowl and wading birds such as the great blue heron.

Wildlife habitat protection objectives can be met through legacy planning practices. The more hands-off preservation approach can be used to protect non-game species in healthy, fully functioning hardwood forests. However, active management with NNIS monitoring and treatment at minimum is required to maintain this forest type and its habitat components.

5.2.5. Recreation

Many landowners enjoy a variety of active and passive outdoor recreation. From simply hiking their woods and wildlife viewing to hunting and off highway vehicles. Those that live onsite may recreate on their forests daily, others may live across the state or country and only visit during hunting season. In fact, a 2016 analysis commissioned by the South Carolina Department of Natural Resources and conducted by Clemson University indicated that the annual economic impact of fishing, hunting, and wildlife viewing on the South Carolina economy is estimated at \$2,736,886,553.

(https://www.clemson.edu/cafls/departments/fec/news/files/fw_13-economic_contributions_of_natural_resources_2.pdf)

Pine forests and hardwood forests alike are popular recreational areas in South Carolina, especially in the cooler, dryer months. The open, park-like stand structure of pine forests provides a scenic backdrop for a variety of recreational activities. Hardwood forests also provide similar activities, especially when the biting insects subside in cooler months. Below are examples of these various forest-related recreational activities.

- Hunting and leases
- Geocaching
- Bicycling
- Off-highway vehicles (OHV) and leases
- Equestrian
- Wildlife viewing and birding
- Camping
- Hiking
- Environmental education
- Various Water sport activities

5.2.6. Aesthetics

Landowners seek a certain “look and feel” from the visual appearance of their forests. Forest aesthetics spark a sense of personal landowner pride, stewardship, privacy, and even adventure. Many landowners maintain and enhance their forest aesthetics for their family, community, neighbors and passers-by to enjoy. Forest management activities consistent with the size of the forest, the scale and intensity of forest management activities, and the location of the property tend to increase the aesthetic value. Forest resource professionals can assist landowners with implementing and managing silvicultural options in a manner that increases aesthetic value of the property.

Over the course of time, a wide range of aesthetic objectives can be accomplished with the suite of silvicultural tools within this LMP. Even though many silvicultural tools may produce immediate and temporary results that with a decreased aesthetic value, the consistent application and/or long-term results of these operations produce enhanced overall aesthetic value of the forest. For example, the short-term visual conditions produced following a prescribed fire may have minimal aesthetic value, however the resultant functional and aesthetic changes in species composition and midstory and/or nuisance species control becomes evident in just weeks following the burn. Furthermore, the aesthetic condition of consistently burned forestlands increases rapidly with each subsequent prescribed fire event. Likewise, the long-term aesthetic value gained from performing timber thinning operations far outweighs the short-term optics following harvesting operations. Landowners are rewarded with a sense of pride when their hard work and investment in management activities results in aesthetic accomplishments.

5.2.6.1. Pine Forest Aesthetics

Well managed pine forests often meet some landowners’ objective for aesthetics. Mature stands that have been prescribed burned and/or thinned have an open, park-like structure with large, well-formed pines and little to no midstory. Stands with native groundcover typically have lush green grasses, herbs and shrubs in the spring following prescribed fire and a sea of wildflowers or, in longleaf pine stands, wiregrass in the fall. Some loblolly, shortleaf, or longleaf pine stands are so open you can see through these rolling forests for a mile or more. Young stands with quality groundcover managed with the LMP’s appropriate silvicultural tools have the potential for the same stand structure and aesthetics with time.

Silvicultural tools can be used to maintain and enhance aesthetics. Forest operations can be planned with aesthetics in mind to ensure these objectives are met. For example, when clearcutting a pine stand, a strip of pines can be left as a buffer against adjacent high visibility areas such as roadways or neighboring homes. Or during thinning operations, logging decks can be placed within the stand interior, away from roadways. These forested strips can be managed as an even-aged forest on a cutting cycle that ensures the adjacent stand they are buffering is forested before they are clear-cut, or they can be managed as an uneven-aged forest and passively managed on the same cutting cycle as the even-aged stand they are buffering.

5.2.6.2. Hardwood Forest Aesthetics

Hardwood forests have high quality, varying aesthetics across the different forest types that compose this category. The overstory diversity of hardwood forests provides character and variety compared to the pine-dominated forests. Most upland hardwood and mixed floodplain forest types provide rare opportunities in South Carolina for fall foliage colors. While upland slope forests provide relatively steep topography and

vegetation that are indicative of the Piedmont region of the United States, the aesthetic qualities of mixed floodplains mainly exist in the rivers, creeks, and streams that punctuate mixed floodplain forest types' overstory diversity and uneven-aged structure.

Tupelo-cypress mixed forests have their own high-quality aesthetics, with both having a unique form with buttress-based stems and cypress extending knees from their roots. They are often draped with Spanish moss. This gives them a pleasantly eerie and prehistoric look that is quite unique across the landscape. Cypress is one of the few deciduous conifers in the world and turns a stunning auburn in the fall before dropping its' needles. Swamp tupelo also changes to red, providing some color in a relatively bland South Carolina fall. While Carolina bays are relatively bland in color due to their domination by sweetbay magnolias, the scattered black gum and sweet gums, cypress, and maple provide splashes of color for the fall season. Carolina bays also provide a visually appealing landscape when compared to surrounding habitat due to their uniqueness among surrounding forest land.

Most uplands in South Carolina are pine dominated and even-aged, and provide their own type of beauty, but hardwood forests are less common, natural, uneven-aged and possess a lot of character. These aesthetic characteristics often provide landowners incentives to exclude silvicultural management in these forests, especially those presently in a desired future condition. Thus, upland hardwood forests are often solely preserved for their regional unique character and beauty.

Silvicultural tools can be used to maintain and enhance aesthetics. Forest operations should be planned with aesthetics in mind to ensure these objectives are met. For example, when clearcutting hardwood stands, a strip of hardwoods can be left as a buffer against adjacent high visibility areas such as roadways or neighboring homes. These forested strips can be managed as an even-aged forest on a cutting cycle that ensures the adjacent stand they are buffering is forested before they are clear-cut, or they can be managed as an uneven-aged forest and passively managed on the same cutting cycle as the even-aged stand they are buffering.

5.2.7. Legacy Planning

Some landowners have a legacy planning objective because they would like to see their forest ownership remain intact and capable of being passed down between generations. The protection of the forested ecosystem from conversion to development, fragmentation, and/or degradation from alternate uses (e.g. mining) is a benefit of the legacy planning objective, yet it could also be a benefit of the conservation objective.

Landowners that treat their forestland as an untouched "preserve" and do not actively manage their forest will observe changes in forest type more quickly. However, many of South Carolina's forest types (i.e. pine) are fire dependent and at a minimum require active management with prescribed fire (or equivalent successional and fuel reduction measures) for ecological maintenance.

Conservation and legacy planning are both founded upon the desire to ensure future use of a natural resource. Many landowners seek to achieve a balance between conservation and legacy planning objectives by utilizing silvicultural tools to mimic ecological processes (conservation) and restricting human activities outside their interests (legacy planning).

Pine forests are fire dependent and require frequent application of prescribed fire at minimum for ecological maintenance. These forests are not conducive to legacy planning-oriented, single-use management. Preservation of pine forests will result in long-term succession to hardwood forest due to lack of prescribed fire application.

Some hardwood forest types are more conducive to legacy planning-oriented, single-use management than upland pine and other fire-dependent forest types. However, without active management and landowner engagement this may cause ATFS de-certification.

5.2.7.1. Ownership

5.2.7.1.1. Filing Types

The different ownership forms in which forest property is held is important from a tax standpoint. Additionally, if the forest property is counted as a business, the type of business chosen can also affect the tax structure of the property. Nontax factors can also influence the business type chosen, such as forest management goals, the property's size, consideration of the owner's family, and the potential income needed from the property. The final decision of which ownership form a property should take is dependent on an analysis of these and other factors. Some characteristics of selected ownership types are discussed below, while an overview of the different types available can be found through the Forest Landowners Guide to the Federal Income Tax's [Form of Forest Land Ownership and Business Organizations](#).

Basic Ownership Types

Sole Ownership

Sole ownership is the most basic form of timber property ownership and is composed of one owner controlling every aspect of the property management. This provides the greatest amount of control over the property. A benefit of this ownership type is profit or loss from the business endeavors can be accounted separately from the owner's other income sources.

Co-Ownership

Co-ownership represents the undivided ownership of property by two or more persons. This form of ownership is often used as a simpler form of more complex business arrangements, and transfer of a co-ownership at death can often be completed easily and inexpensively. A potential disadvantage to this ownership type is that business transactions must have the approval of both parties, as one owner does not have autonomy and control. The most common types of co-ownership are [Tenancy in Common](#), [Joint Tenancy](#), and [Tenancy by the Entirety](#).

Business Ownership Types

LLC

A way that forest owners can create a preserved property to pass down through generations is the creation of a corporation (including Limited Liability Company [LLC]). Having forest land under an LLC reduces tax liability from the IRS and strives to ensure that the property is less likely to be divided by heirs in the future. There are four different mechanisms to keep properties intact and in the family for future generations: a family partnership, closely-held S-corporation, qualified trust for conservation purposes, or, as discussed

here, an LLC (McEvoy 2003). LLCs offer a level of flexibility to landowners, as the LLC can be dedicated to any purpose (investment, business, conservation, or any combination of motives). LLCs can also offer the benefits similar to the three other aforementioned mechanisms for property ownership: the liability protection of a corporation, pass-through taxation aspects of a partnership, and the ability to limit ownership in the family forest provided by a closely-held S-corporation. Also, LLCs can grow as a family does, as the founders of the LLC can set either fractional family membership, having more than one membership class, or having no limitations with regard to the number of owners.

With this ability of an LLC to set membership classes to distribute responsibility within a family, it is less likely that the property will be split by heirs over time. If a property is split once, the likelihood of it being further split and developed is much greater than if the entire property remains intact under the LLC mechanism. The LLC can allow family members to share in the receipt of both tangible and intangible forest benefits, but without the strain of any one family member feeling the burden to continue the family's property legacy. In essence, the LLC treats the family not as separate entities with one member bearing the majority of the responsibility, but as a company that leaves generations to enjoy the benefits of forests with less hassles. An LLC also provides the added benefit of qualifying for different cost-share programs that require a single Employer Identification Number (EIN) for tax purposes.

Further information for creating and registering a business in South Carolina for a property can be found at the [South Carolina Secretary of State](#) website.

Partnerships

Partnerships are most basically an association of two or more people that conduct a business for profit as co-owners. States have developed their own legality as to what constitutes a partnership, as oral partnership agreements are not considered legally binding everywhere; therefore, it is important to have all details of the agreement in writing. The contributions of the partners to the partnership do not have to be equal. Assets that enter the partnership or are purchased within the partnership become property of the partnership. Some common considerations within partnerships are unlimited liability, minors as partners, and taxation of partnerships.

Corporations

A corporation is a separate legal entity that has most of the rights of an individual, while being owned by its shareholders and governed by a stakeholder-elected board of directors. The most notable feature of a corporation is the limited liability falling to the shareholders, as legal actions against a corporation are covered through the corporate assets while shareholder assets are protected. Subchapter S Corporations are a form of corporation that is restricted by various limitations, including the limiting of members to 100.

5.2.7.1.2. Forest Legacy Challenges

Estate Planning

Most nonindustrial private forest land in the United States is owned by individuals, married couples, family estates and trusts, or other types of family groups (Siegel et al. 2009). Within private forest land ownership, the estate tax structure is in a constant state of flux; this presents potential danger for estates with substantial forest land holdings. If estate planning is not conducted properly, risks such as forced liquidation of family forest landholdings or the severe fragmentation or disruption of forest land are a real possibility.

As a private forest landowner approaches retirement or faces the possibility of death, certain issues regarding the future of their land must be addressed. There are multiple costs and aspects to consider if retiring or dying with an unprepared future for forest landholdings, such as transfer costs, unexpected heirs, the continuity of forest land management, and keeping forested land from becoming liquidated or parcelized. The US Forest Service developed the publication [Estate Planning for Forest Landowners: What Will Become of Your Timberland?](#) to provide guidelines for nonindustrial private forest owners concerning the application of estate planning techniques to their forest properties.

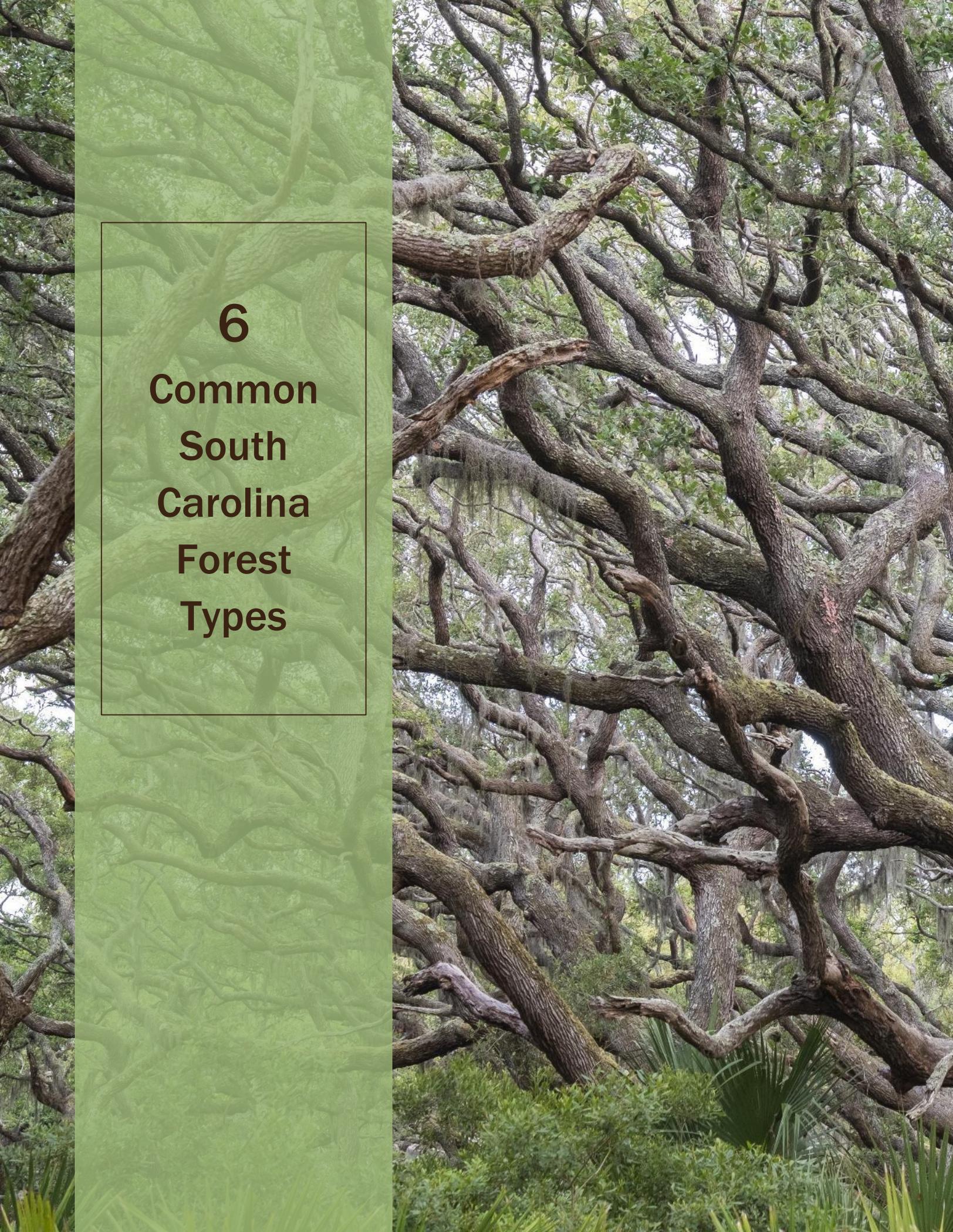
Heirs' Property

Another potential challenge when dealing with forest legacy planning is the issue of Heirs' Property. Heirs' Property is any land or associated dwellings that are owned jointly by descendants of a deceased person whose estate proceedings were not handled in Probate Court (Watts Law Firm PA, 2019). After the Civil War in South Carolina, many former slaves purchased or were deeded land throughout South Carolina. When these lands were passed down through descendants, the property rights for many lands were passed down orally and no written contract was devised. Due to this ambiguity of ownership and lack of written contract, the land in question may be considered heirs' property.

An often overlooked aspect of heirs' properties is that the land in question does not just belong to the family that resides on or pays taxes on the land, but to all heirs regardless of their location. This creates a land management challenge, as some descendants may wish to sell their particular portion of the land while others may wish to keep it their entire life. Further complicating the distinction of land ownership is the issue of each new generation further skewing the family tree; if one particular branch of the family has more descendants, they own a larger portion of the property.

The ideal solution to heirs' property issues is to have all heirs gather to discuss preferences regarding the property and come to an amenable conclusion for how to handle the land. If the lineage of the original landowner is unknown, research must be conducted to determine each heir of the property and their share. Title to the property can be cleared by one party's renunciation of property ownership or the transfer of their share to another heir. If no agreement can be reached among the heirs, litigation is an option. Once a cleared title is owned by a party, there is the freedom to build a home, mortgage the property, sell timber, or conduct other activities on the land.

For additional information regarding heirs' property, visit the [Center for Heirs' Property Preservation](#).



6
Common
South
Carolina
Forest
Types



6. COMMON SOUTH CAROLINA FOREST TYPES

This section will discuss the common forest types and general stand conditions natural resource professionals may encounter while working with landowners in the state of South Carolina. Since this LMP is forestry specific, forest type is defined here as a classification of forests by dominant overstory species or group of species (e.g. slash pine or mixed hardwoods). Forest type is not to be confused with the term natural community because each forest type may contain multiple natural communities. Likewise, a given natural community may be dominated by a variety of forest type species.

An example would be the mesic pine flatwoods natural community which could be dominated by longleaf pine or loblolly pine. Therefore, the mesic pine flatwoods natural community could occur in both the longleaf pine and loblolly pine forest types. Referring to The Natural Communities of South Carolina distributed by the South Carolina Department of Natural Resources may be useful in helping meet landowner objectives. Detailed natural community descriptions, species lists, and other information on all the natural communities of South Carolina can be found in the document as well. South Carolina natural communities associated with the LMP's Common South Carolina Forest Types are discussed within each respective forest type section. Refer to [Table 4](#) for a listing of the common, dominant overstory species by associated LMP forest type. For this table, the respective species composition for the different forest types was found within the South Carolina Department of Natural Resource's Natural Communities of South Carolina. Multiple Communities of South Carolina comprise each LMP Forest Type (i.e. Bottomland Hardwoods Forest Type contains Piedmont seepage forest, swamp tupelo pond, and bottomland hardwood forest Communities of South Carolina).

In this section, the landscape objectives for each forest type will be discussed as well. Since some objectives are not applicable across all forest types within South Carolina, they will be further discussed below the forest type they involve.

Table 4 Common tree species by LMP Forest Type

Common Name	Scientific Name	Loblolly pine dominant	Longleaf pine dominant	Shortleaf pine/ hardwood mixed	Loblolly pine/ hardwood mixed	Upland hardwoods	Bottomland hardwoods	Maritime forests
Red maple	<i>Acer rubrum</i>	x		x		x	x	
American hornbeam	<i>Carpinus caroliniana</i>				x		x	
Water hickory	<i>Carya aquatica</i>						x	
Bitternut hickory	<i>Carya cordiformis</i>						x	
Pignut hickory	<i>Carya glabra</i>			x	x	x		
Red hickory	<i>Carya ovalis</i>				x	x		
Shagbark hickory	<i>Carya ovata</i>				x	x	x	
Mockernut hickory	<i>Carya tomentosa</i>			x	x	x	x	
Sugarberry	<i>Celtis laevigata</i>						x	
Atlantic white cedar	<i>Chamaecyparis thyoides</i>						x	
Black titi	<i>Cliftonia monophylla</i>		x				x	
Flowering dogwood	<i>Cornus florida</i>	x	x	x	x	x	x	x
Swamp dogwood	<i>Cornus foemina</i>						x	
Swamp titi	<i>Cyrilla racemiflora</i>		x				x	
American beech	<i>Fagus grandifolia</i>	x		x		x		
White ash	<i>Fraxinus americana</i>					x		
Carolina ash	<i>Fraxinus caroliniana</i>						x	
Green ash	<i>Fraxinus pennsylvanica</i>						x	
American holly	<i>Ilex opaca</i>	x			x	x	x	x
Yaupon holly	<i>Ilex vomitoria</i>	x	x		x			x
Southern red cedar	<i>Juniperus silicicola</i>							x
Eastern red cedar	<i>Juniperus virginiana</i>			x				x
Mountain laurel	<i>Kalmia latifolia</i>			x		x	x	

Common Name	Scientific Name	Loblolly pine dominant	Longleaf pine dominant	Shortleaf pine/ hardwood mixed	Loblolly pine/ hardwood mixed	Upland hardwoods	Bottomland hardwoods	Maritime forests
Sweetgum	<i>Liquidambar styraciflua</i>	x		x	x	x	x	x
Tulip tree	<i>Liriodendron tulipifera</i>					x		
Magnolia	<i>Magnolia grandiflora</i>	x			x		x	x
Sweet bay	<i>Magnolia virginiana</i>		x				x	
Wax myrtle	<i>Morella cerifera</i>		x					x
Red mulberry	<i>Morus rubra</i>						x	
Water tupelo	<i>Nyssa aquatica</i>						x	
Swamp tupelo	<i>Nyssa biflora</i>						x	
Tupelo	<i>Nyssa sylvatica</i>	x	x	x	x	x	x	
American hop hornbeam	<i>Ostrya virginiana</i>				x	x		
Sourwood	<i>Oxydendrum arboreum</i>			x		x		
Red bay	<i>Persea borbonia</i>					x		x
Swamp bay	<i>Persea palustris</i>				x		x	
Shortleaf pine	<i>Pinus echinata</i>		x	x	x	x		
Slash pine	<i>Pinus ellioti</i>				x			x
Spruce pine	<i>Pinus glabra</i>	x					x	
Longleaf pine	<i>Pinus palustris</i>		x		x			
Eastern white pine	<i>Pinus strobus</i>					x		
Loblolly pine	<i>Pinus taeda</i>	x	x		x	x	x	x
Virginia pine	<i>Pinus virginiana</i>					x		
Planertree	<i>Planera aquatica</i>						x	
American Sycamore	<i>Plantanus occidentalis</i>						x	
White oak	<i>Quercus alba</i>	x				x	x	
Scarlet oak	<i>Quercus coccinea</i>			x		x		

Common Name	Scientific Name	Loblolly pine dominant	Longleaf pine dominant	Shortleaf pine/ hardwood mixed	Loblolly pine/ hardwood mixed	Upland hardwoods	Bottomland hardwoods	Maritime forests
Southern red oak	<i>Quercus falcata</i>	x	x	x	x	x	x	
Bluejack oak	<i>Quercus incana</i>		x					
Turkey oak	<i>Quercus laevis</i>		x					
Laurel oak	<i>Quercus laurifolia</i>	x			x	x	x	x
Overcup oak	<i>Quercus lyrata</i>						x	
Blackjack oak	<i>Quercus marilandica</i>		x			x		
Swamp chestnut oak	<i>Quercus michauxii</i>						x	
Dwarf live oak	<i>Quercus minima</i>							x
Water oak	<i>Quercus nigra</i>	x	x	x	x	x	x	x
Cherrybark oak	<i>Quercus pagoda</i>						x	
Willow oak	<i>Quercus phellos</i>	x		x		x	x	
Chestnut oak	<i>Quercus prinus</i>					x		
Northern red oak	<i>Quercus rubra</i>					x		
Shumard oak	<i>Quercus shumardii</i>						x	
Post oak	<i>Quercus stellata</i>	x	x			x		
Black oak	<i>Quercus velutina</i>					x		
Live oak	<i>Quercus virginiana</i>				x			x
Sabal palm	<i>Sabal palmetto</i>							x
Sassafras	<i>Sassafras albidum</i>	x	x			x		
Cypress	<i>Taxodium sp.</i>						x	
Winged elm	<i>Ulmus alata</i>			x			x	
American elm	<i>Ulmus americana</i>	x					x	

6.1. Loblolly Pine Dominant

Loblolly pine is a highly valuable commercial species in South Carolina. It is often planted in dense, productive plantations with genetically-improved seedling stock. It is often even-aged-managed on revenue-maximizing short rotations, although it can also be managed on an uneven-aged basis, although to a lesser degree than longleaf. It is generally managed on shorter rotations for pulpwood, oriented strand board and chip-n-saw. However, it can be managed on longer rotations for high-value products such as sawtimber, poles and ply logs. Refer to Table 4 for a listing of the common species comprising the loblolly pine dominant forest type.

Loblolly pine is second in the state behind longleaf pine in terms of disease, insect, and fire resistance, and is not very drought tolerant. Loblolly pine is not only economically valuable but is a key ecological component in upland pine and several wetland natural communities. Revenue and conservation objectives can be balanced or achieved individually through loblolly pine management.

Loblolly pine grows in several types of wetlands and their ecotones, but thrives in productive clay uplands. It shares upland pine sites in variably mixed stands with longleaf and shortleaf pines, southern red oak (*Quercus falcata*) and hickory (*Carya* spp.) among other hardwoods. Loblolly is found sparsely on mesic and wet flatwoods sites, particularly adjacent to wetlands. It is considered offsite on excessively well-drained sandy soils of the Sandhills, but can be found marginally on these sites. Loblolly can also be found in savannas on these drier upland sites. Loblolly pine savannas contain a diverse assemblage of plants, along with certain rare wildlife species. As previously mentioned, the Working Lands for Wildlife Program for South Carolina is working toward the reestablishment of bobwhite in this pine savanna habitat.

6.2. Longleaf Pine Dominant

Longleaf pine is a popular forest type due to its high regional ecological, social, cultural and biological values. Longleaf pine is the most disease, insect and fire resistant of all the southern pine species and is very drought tolerant (Burns and Honkala 1990). South Carolina longleaf pine historically grew in mesic savannahs or mesic/wet/scrubby flatwoods, upland pine and upland mixed woodland natural communities ranging from the coast to inland as far as 200 miles. Longleaf pine is a long-lived species with relatively slower growth characteristics compared to loblolly pines, particularly for the first one to five years. Once it reaches the “rocket stage” (rapid vertical growth), growth rates are comparable to other pine species. This relatively slower growth rate and other physiological characteristics produce high quality sawtimber and pole products. It is often managed on longer rotations for these high-value products compared to shortleaf and loblolly pines. Refer to Table 4 for a listing of the common species comprising the longleaf pine dominant forest type.

Longleaf favors moderately to well-drained, deep, sandy, acidic, nutrient poor soils but also thrives on rich, moderately well drained clay hills (Burns and Honkala 1990). It grows in nearly pure stands on sand hills aside scattered mixed scrub oak species and some marginal slash or loblolly pine. Longleaf can also be found in savannas on these drier upland sites. Longleaf pine savannas contain some of the world’s most diverse assemblages of plants, along with certain rare wildlife species. As previously mentioned, the Working Lands for Wildlife Program for South Carolina is working toward the reestablishment of bobwhite in this pine savanna habitat.

In mesic and wet flatwoods, it can be found in variably mixed stands, with little to no hardwood midstory in managed stands. On upland pine and upland mixed woodland sites longleaf grows alongside shortleaf pine, loblolly pine, southern red oak (*Quercus falcata*) and hickory (*Carya* spp.), among other hardwoods. Scattered natural longleaf can be found growing in wetlands and more so in their ecotones. However, longleaf is difficult to artificially establish on wetter sites, especially if regular fire disturbances have been absent for twenty years or more.

There are many [economic and ecological incentives](#) for landowners to manage for longleaf pine. Landowners may become a valuable part of the landscape-level restoration of longleaf pine. Longleaf is an ecologically and commercially valuable species that allows for single-use or multiple-use management.

The longleaf pine ecosystem has one of the richest species diversities of any ecosystem in the world outside of tropical rainforests (Noss 1989; Peet and Allard 1993; Jose et al 1990). Wiregrass (*Aristida stricta*) commonly dominates the diverse, pyrogenic understory of longleaf forests located in the Sandhills, but is conspicuously absent around the central Sandhills near Columbia, SC. Many endemic wildlife species of longleaf pine forests prefer its open stand structure, including gopher tortoise, fox squirrel, and wild turkey. Frequent, low-intensity prescribed fire is essential for maintaining and restoring this ecosystem and its diversity.

Longleaf is usually managed as an even-aged forest. However, with its open crown, sporadic seeding, and early fire resistance, longleaf is well suited for uneven-aged management, providing landowners the option of managing for a steady, long-term income stream through single-tree selection or group selection harvests. This allows for a mix of products per harvest and meeting a mix of objectives, such as [aesthetics](#).

For more information on the history and restoration efforts of longleaf pine forests, refer to the [Forest Ecological Restoration](#) section.

6.3. Shortleaf Pine/Hardwood Mixed

Shortleaf pine is an important lumber species in South Carolina. Shortleaf pine is most productive and common on the dry hills of the Piedmont region of the state, but is currently found within every county and [ecoregion](#) of the state (The Pines of South Carolina 2019). It is offsite on deep, excessively-drained sandy soils, or poorly-drained clay soils resulting from erosion. Refer to [Table 4](#) for a listing of the common species comprising the shortleaf pine/hardwood mixed forest type.

Shortleaf pine commonly grows on moderately to well-drained clay soils like loblolly pine. It shares upland pine sites with [longleaf](#) and loblolly pines and mixed hardwoods such as southern red oak. This section will focus on shortleaf pine on upland pine sites. It grows alongside longleaf, oaks and hickories on upland mixed woodland sites. Within dry upland hardwood forests, shortleaf can be found scattered with loblolly pine and dominant mixed hardwoods.

Shortleaf mostly occurs scattered in natural, uneven-aged, mixed hardwood-pine stands. On appropriate soils shortleaf can be planted and managed, but loblolly is generally more productive on these sites. It is generally found growing in natural stands that produce pulpwood and oriented strand board products. On the limited, better South Carolina managed shortleaf sites, it can produce chip-n-saw, sawtimber and ply logs.

Due to erosion from past farming practices in the Piedmont, a significant portion of suitable sites for shortleaf have decreased while the incidence of littleleaf disease has increased. Shortleaf suffering from littleleaf disease are more susceptible to southern pine beetles (SPB), making pine stands within the Piedmont containing shortleaf more at risk to SPB. Littleleaf, SPB, and loblolly's better growth and resistance to littleleaf are some of the main reasons most natural shortleaf and shortleaf/hardwood mixed stands in the Piedmont have been converted to loblolly. This decline in shortleaf has occurred across the Southeast and has spurred the [Shortleaf Pine Initiative](#), a restoration effort of shortleaf pine forests across its natural range.

Other than littleleaf disease, shortleaf pine exhibits relatively good disease and insect resistance. Shortleaf seedlings and saplings readily sprout from the base following excessive fire damage, making its fire resistance more in line with longleaf than loblolly. Shortleaf is an ecological component in upland pine (loblolly mixed), upland mixed woodland and dry upland hardwood forest [natural communities](#); combined loblolly and shortleaf pine comprise nearly 44% of all South Carolina forest types (Brandeis et al. 2017). [Economic return](#) and [conservation](#) objectives can be balanced or achieved individually through shortleaf management.

Shortleaf pine is shade intolerant and is best suited for even-aged management, providing landowners the option of managing intensively and maximizing revenue with short rotations. Shortleaf also allows the flexibility to grow stands out longer mainly for timber but also for aesthetic and wildlife objectives. It has been successfully uneven-aged-managed, which can be a good fit for natural stands of shortleaf on private lands.

6.4. Loblolly Pine/Hardwood Mixed

Loblolly pine/hardwood mixed forest type is a combination of uneven-aged, natural [forest types](#) which includes multiple upland [natural communities](#). Refer to [Table 4](#) for a listing of the common, dominant overstory species comprising the loblolly pine/hardwood mixed forest type.

The natural communities within loblolly pine/hardwood mixed are each similar in silvicultural operability to other xeric sites in South Carolina. This forest type is found state-wide within the uplands of South Carolina, and species composition within this forest type varies based on hydrology and elevation from site to site. These forests usually result from long-term fire exclusion, but are usually found within the ecotone where bottomland forests and upland pine forests meet. Upland pine has been collectively represented and covered within the [loblolly pine](#) and [shortleaf pine](#) forest type sections.

Loblolly pine/hardwood mixed forests have lower timber productivity than loblolly stands due to the interspersed hardwood species and generally are not actively managed, aside from upland pine. They are not fire tolerant/dependent, aside from upland pine and upland mixed woodland. Soils, productivity, and timber quality vary greatly across these sites. Loblolly pine-hardwood mixed forests produce pine products similar to loblolly pine dominated forests and also low value products such as hardwood pulpwood and fuelwood. These forests usually have understories dominated by shade tolerant hardwoods which are best suited for uneven-aged management. Loblolly pine/hardwood mixed forest types allow the flexibility to manage for timber while also meeting [aesthetic](#) and [wildlife](#) objectives.

6.5. Upland Hardwoods

Upland hardwood (UH) communities represent a mixture of hardwood tree species with little to no presence of pine species. The associated natural communities according to The Natural Communities of South Carolina (Nelson 1986) include: basic forest, beech-magnolia hammock, chestnut oak forest, hemlock forest, [maritime forest](#), oak-hickory forest, mixed mesic hardwood forest, and Southern mixed hardwood forest. This forest type is variable depending on location and found throughout the state. This forest type is similar in composition to other mesophytic and riparian forests found throughout the state. Soils within upland hardwoods are typically sub-xeric and acidic, varying from quite sandy to clayey depending on where they are found in South Carolina and the surrounding habitat. See [Table 4](#) for a listing of the common tree species for the upland hardwoods forest type.

In comparison to the pine-dominated upland forest types, upland hardwood forests usually have longer timber rotations requiring little management. Soils, productivity, and timber quality vary greatly across these hardwood sites. UH forests dominated by shade intolerant species, such as oaks, growing on productive soils are capable of producing quality [sawtimber](#). UH forests dominated by shade tolerant species, such as red maple, growing on sub-xeric soils produce mostly low value products such as hardwood pulpwood and fuelwood. Although not usually regarded as fire tolerant/dependent, research has shown that fire applied at the beginning of an UH rotation has increased more valuable shade-intolerant species such as oaks. UH forests are important for wildlife because of the annual mast production they provide. These forests also allow the flexibility to manage for timber while also meeting [aesthetic](#) and [wildlife](#) objectives.

6.6. Bottomland Hardwoods

Bottomland hardwood (BH) communities are typically river swamps found along streams and rivers throughout the southeast and south-central United States. These habitats are generally lacking in slope due to their presence within the broad, flat floodplains of their associated hydrologic feature, also BH communities within the Piedmont and Appalachian regions of South Carolina usually exhibit higher ranges of topography, resulting in a more narrow floodplain. Due to their presence in floodplains, BH soils typically consist of alluvial sediment ranging from clay to sand depending on the features (size, water velocity, etc.) of the nearby stream or river. All species within BH communities are dependent on occasional flooding, with the flooding regime determining which species are best adapted for each habitat.

In South Carolina, Bottomland Hardwoods can be found along black river floodplains and red river floodplains. Black rivers drain smaller watersheds, originate within the coastal plain region, and can either empty into larger red rivers or into the Atlantic Ocean. Red rivers drain larger watersheds, originate within the Piedmont and Blue Ridge regions, and flow through the Coastal Plain region before emptying into the Atlantic Ocean (North Carolina Forestry Library 2009). Black rivers are named because of their nutrient-poor, high organic content found in the coastal plain, and red rivers are named because of their nutrient-rich, high clay and mineral content found throughout the Piedmont and Blue Ridge. Red river floodplains are usually larger and more productive than black river floodplains (Messina and Conner, 1998). In the Coastal Plain region, BH forests of both rivers are composed largely of oaks (cherrybark, swamp chestnut, laurel, and willow), while other hardwoods present include bitternut hickory, green ash, and sweetgum (USFWS 2014). Where little topography relief exists, cypress and tupelo become more prevalent in both rivers, with pond cypress being more prevalent along black rivers and bald cypress along red rivers. BH forests along

red rivers in the Piedmont are usually smaller in area due to the higher gradients and topography changes, and consist of the oaks and hickories found within the Coastal Plain but also a larger population of red maple, American elm, sycamore, and river birch (North Carolina Wildlife Resources Commission 2019).

In comparison to the pine-dominated upland forest types, bottomland hardwood forests have limited access and generally are not actively managed. On shorter rotations, BH forests produce mostly low value products such as hardwood pulpwood and fuelwood, but on longer rotations, BH forests, especially along red rivers, can produce high value sawtimber and veneer products. Harvests should maintain natural water-flow patterns and take into account of the regeneration of the next forest, from seed, seedling or stump sprouts. BH forests exist from small-and-large- scale disturbances, and ones dominated with shade tolerant hardwoods have usually been high-graded over time (Messina and Conner, 1998). BH allows the flexibility to manage for timber while also meeting [aesthetic](#) and [wildlife](#) objectives.

The associated natural communities within the BH designation according to The Natural Communities of South Carolina (Nelson 1986) include: bald cypress-tupelo gum swamp, bay forest, bottomland hardwoods, oak-hickory forest, small stream forest, and streamhead pocosin. After conferring with a group of natural resource professionals from South Carolina, however, it was determined that for the purpose of landscape management within this plan, the only two distinct subdivisions under the BH designation aside from the general BH category that warrant further discussion are the tupelo-cypress mixed and Carolina bay forest types.

6.6.1. Tupelo-Cypress Mixed

Tupelo-cypress mixed communities are relatively small, isolated wetlands embedded within Bottomland Hardwood Forests or also various upland, pyrogenic [natural communities](#). Pond or bald cypress (*Taxodium distichum* var. *nutans* or *Taxodium ascendens*) and swamp or water tupelo (*Nyssa sylvatica* var. *biflora* or *Nyssa aquatica*) are relatively slow-growing and dominate this forest type together or in pure stands. Bald cypress and water tupelo are usually found in deepwater swamps along red rivers in the coastal plain, and pond cypress and swamp tupelo are usually found in deepwater swamps along black rivers. Water tupelo and bald cypress become more dominant with increasing hydroperiods along both rivers. Because of its thicker, fire-resistant bark, pond cypress becomes more dominant in isolated ponds, stringer swamps and black rivers located in more pyrogenic natural communities (Messina and Conner, 1998). Isolated ponds have a hydroperiod that lasts most of the year, with tupelo-dominated ponds having a longer hydroperiod than pond cypress-dominated. Pond cypress-dominated stringer swamps occur along intermittent streams that only flow following heavy rainfall. They occur on relatively unproductive organic muck, wet sand and peat soils. These typically even-aged forest types can be managed sustainably by using the [SC BMPs for Forestry](#).

Cypress/tupelo ponds can contain various mixed hardwoods including bays (*Persea* spp., *Gordonia lasianthus*, and *Magnolia virginiana*), red maple (*Acer rubrum*), holly (*Ilex* spp) and swamp titi (*Cyrilla racemiflora*). Cypress-dominated ponds and stringer swamps generally occur within pine flatwoods and sand hills, while tupelo-dominated ponds generally occur within upland pine natural communities.

In comparison to the pine-dominated upland forest types, these tupelo-cypress mixed forests have relatively low timber productivity and value and generally are not actively managed silviculturally on most private

lands. However, silvicultural opportunities exist within these communities. Cypress dominated ponds and stringers are shade intolerant and best suited for even-aged management. Gum ponds are shade tolerant, but typically managed even-aged as well. The tupelo-cypress mixed forest type allows the flexibility to manage for timber while also meeting aesthetic and wildlife objectives. These forests produce mostly low value products such as hardwood pulpwood, fuelwood and cypress mulch. Mature cypress stands can produce saw logs used for various ornamental products such as tables, trim and furniture.

6.6.2. Carolina Bay

The Carolina bay forest type, so-named due to its abundance of bay trees, is a type of elliptically-shaped freshwater depressional wetland that may alternate between periods of saturation or periodic dryness depending on rainfall. Carolina bays, or pocosins as they are sometimes called when containing a greater accumulation of black mucky soil, are found throughout South and North Carolina, with others scattered in Virginia, Delaware, and Georgia. Soils within Carolina bays are typically mucky and high in organic content, occasionally underlain with sandy substrate (Myers and Ewel 1990). They are fire-dependent systems, and are oriented in a northwest-southeast direction, parallel to each other. Carolina bays usually are characterized completely or partly by eight distinctive features: 1) an elliptical or ovoid shape 2) northwest-southeast orientation 3) parallel axes 4) raised sand rims 5) depressed interior surfaces 6) a difference between interior and surrounding soils 7) relatively shallow depths and 8) flat sandy bottoms beneath the interior (SCDNR 2015). Carolina bays provide refuge for multiple rare plants and animals, most notably amphibians and birds.

Carolina bays have soils that are rich with peat due to organic matter accumulations over time, and can have shorter, low-growing vegetation, taller trees, or no vegetation at all in the interior if they are permanently inundated (Myers and Ewel 1990). The canopy layer of Carolina bays is generally thick with pond pine, loblolly bay, pond cypress, swamp tupelo, and various bay species, with a tangled subcanopy comprised of vines and tall shrubs such as wax myrtle and Atlantic white cedar (*Chamaecyparis thyoides*).

Carolina bays are not only fire tolerant, but they are usually regarded as fire-dependent, since a lot of the vegetation requires fire to complete their life cycle. Pond pines must have heat from an intense fire to open their serotinous cones and disperse their seeds, which ensures their seeds will have clean areas to grow. Many shrubs have sclerophyllous leaves, which are reinforced with lignin and have thickened cuticles. This adaptation is thought to be more of an adaptation to drought rather than high moisture conditions, but is generally regarded as a means of increasing nutrient efficiency within poor nutrient habitats. Many shrubs contain leaves with secondary chemicals that reduces herbivory, but increases their flammability (Conner and Messina, 1998).

Carolina bay forests produce mostly low value products such as pine and hardwood pulpwood and fuelwood, if they are harvested at all. Fires within these forests would have been infrequent (every 15-50 years), but are known to be very intense and hard to extinguish once the peat layer catches fire (Conner and Messina, 1998). Fires applied to these forests must be done so using extreme caution, but bay forests that have been burned are less likely to have a catastrophic wildfire. It is not a coincidence that the largest wildfires in South Carolina history have occurred within the Lewis Ocean Bay Complex, a series of Carolina bays located in Horry County.

6.7. Maritime Forests

The term “maritime forest” is broadly used to describe a forest type that consists of woody vegetation located near the ocean, either on the mainland or on barrier islands offshore. For the purpose of South Carolina habitat descriptions, maritime forests are a type of coastal habitat that occur on the barrier islands and adjacent mainland of the Atlantic Coast from North Carolina down to Florida (Bellis 1995). The flora and fauna of maritime forests is distinct from that of other South Carolina habitats. This is largely due to the multiple different factors that influence maritime forest habitats, most notably elevated salt content, soil/dune erosion and migration, the limited availability of fresh water, periodic inundation by seawater and salt water intrusion, and wind damage associated with periodic to frequent storms or hurricanes.

Maritime forests often show height limitations due to the impact of salty marine air and exhibit a dominance of woody plant species. Vegetation within this woody dominant strata includes live oak, loblolly and slash pine, yaupon and American holly, southern magnolia, wax myrtle, laurel oak, sabal palmetto, and a variety of other small tree or shrub species (Table 4). Depending on the elevation of the habitat and its proximity to the coast, loblolly and slash pine are both present in maritime forests to a varying degree, sometimes together, but slash pine is limited to the maritime forests of the Southern Coastal Plain ecoregion. The overall presence of maritime forests along the South Carolina coast corresponds closely with the distribution of live oak (Wells 1939). Soils of maritime forests are generally either sandy along dunes or may contain accumulation of peat if the forest is located within an interdunal swale. Regardless of the location, soils tend to be highly permeable, acidic, deficient in nutrients, and poorly developed. Precipitation provides the only natural source of fresh water, with underlying ground water containing salty water.

While maritime forests are essential for storm protection and conserving groundwater, they offer little to no timber productivity and generally are not actively managed, largely due to their location and scarcity of available products. They are not fire tolerant/dependent. Maritime forests produce mostly low value products such as pine and hardwood pulpwood and fuelwood, if they are harvested at all.

7

Forest Resources





7. FOREST RESOURCES

The forest resources discussed below are applicable resources from all forest types in the LMP and may be considered for each landowner. They are summarized below, rather than included in the forest types discussion due to their relative uniform applicability across all forest types. The forest resources particular to each forest type are given in Section 4.2.

7.1. Common Forest Resources

7.1.1. Conservation Incentives

There are several programs and markets available to landowners that can reward them and provide incentives for their conservation efforts. The most widely used programs are cost-shares. A list of some of the major incentives available within South Carolina by providing agency is given below. Additional minor initiatives that may be applicable in certain circumstances are given in [Section 7.1.1.1.2](#).

Table 5 Conservation Incentives, by Providing Agency

Providing Agency	Program Title
USDA Natural Resource Conservation Service (NRCS)/Farm Service Agency/National Initiatives	Conservation Reserve Program
	Emergency Forest Restoration Program
	Healthy Forests Reserve Program
	Environmental Quality Incentives Program
	Conservation Stewardship Program
	National Water Quality Initiative
	Longleaf Pine Initiative (Sandhills Longleaf Pine Conservation Partnership, SoLo ACE Longleaf Partnership, Sewee Longleaf Conservation Cooperative)
	Shortleaf Pine Initiative
	National Bobwhite Conservation Initiative
	Partners for Fish and Wildlife Program
South Carolina Department of Natural Resources/Regional Initiatives	The Heritage Trust Program
	Forest Legacy Program
	Focus Area Program
	ACE Basin Project
	Scenic Rivers Program
	South Carolina Conservation Bank Act
	South Carolina Land Trust Network
	Conservation District Program
	Red-Cockaded Woodpecker Safe Harbor Program
	Farm Bill Technical Support Program
	SC DNR Landowner Incentive Program
Piedmont Prairie Partnership	
South Carolina Forestry Commission	Forest Renewal Program
	Southern Pine Beetle Prevention Program

Some landowners sign conservation easements ensuring this long-term protection. Landowners can enter their property into a conservation easement agreement through various entities such as [The Nature Conservancy](#) or a local land trust. A list of all Land Trust Alliance members operating within South Carolina can be found here: https://www.findalandtrust.org/states/south%20carolina45/land_trusts. Conservation servitudes vary, but most ensure the land is never developed while allowing the landowner to continue management activities such as timber harvests, and in return they receive a property tax break. This option also allows many landowners a strategy during the estate planning process. Some landowners may also be able to earn credits on private mitigation banking markets through the enhancement or restoration of wetlands and/or threatened and endangered species habitat.

7.1.1.1. Conservation Incentives Within Ecoregions

Conservation is essential to maintain the abundant natural resources found in South Carolina. There are multiple Conservation Initiatives (CI) at work in the state that are working to protect these resources. This report will focus on those with components that involve or affect forested habitat or species located within these habitats. It should be noted, though, that this section may not be an entirely comprehensive list of all conservation incentives available to landowners within South Carolina. Research should be personally conducted in conjunction with a forester consultation in order to discern whether other CIs may be available to landowners, as others may be available depending on the time or location.

7.1.1.1.1. National Conservation Initiatives and Programs

The United States Department of Agriculture (USDA) National Resources Conservation Service (NRCS) administers the Environmental Quality Incentives Program (EQIP) to “provide financial and technical assistance to forestry producers to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, reduced soil erosion and sedimentation, and improved or created wildlife habitat.” Through this program, NRCS provides guidance and financial resources to implement environmental improvements. EQIP is available throughout all ecoregions in South Carolina; depending on where your land is located, any number of 200 different forest and farm-focused land improvement practices may be available. Some of these various EQIP practices can be found in subsequent sections of the LMP.

The USDA Farm Service Agency (FSA) administers the [Conservation Reserve Program](#) (CRP). Since its inception in 1985, CRP has been the largest private-lands conservation program in the United States. Through this program, farmers agree to accept a yearly rental payment and participate in cost-share of up to 50% and in return remove lands deemed environmentally sensitive from their normal production and instead plant species to improve environmental quality and health. The contract length for lands enrolled in CRP vary from 10 to 15 years, with the long-term goal of re-establishing valuable land cover to improve water quality, prevent soil erosion, and reduce wildlife habitat loss. The CRP has multiple [initiatives](#) that landowners can choose to participate in, ranging from the [Duck Habitat Initiative](#) to the [Bottomland Hardwoods Initiative](#), which is applicable in the South Carolina wetland forested habitats.

An aquatic initiative active within South Carolina is the National Water Quality Initiative (NWQI). Through this program, the NRCS provides both financial and technical assistance to landowners interested in improving the quality and habitat structure of impaired streams. In South Carolina, the watershed meeting the criteria to be classified as “priority watershed” is the Upper Little Saluda. This watershed contains the Upper Little

Saluda River which flows into the Little Saluda River arm of Lake Murray. Possible sources of contamination within this watershed are failing septic systems, cattle watering in creeks, birds, and wildlife. A main method of improving these watersheds is the control of nutrient and manure runoff into the water bodies. This control may be accomplished through assistance installing cover crops, filter strips, and tailwater recovery systems, which will aid landowners in protecting natural resources voluntarily while also receiving a profit. In South Carolina, the above-mentioned priority watershed is found only in the Piedmont ecoregion.

A forest-based restoration initiative that is present throughout multiple southeastern states is the Longleaf Pine Initiative (LLPI) through NRCS. This initiative seeks to improve the sustainability and profitability of longleaf ecosystems and forests. Through the Farm Bill, landowners in South Carolina receive technical and financial assistance in propagating the spread and protection of these longleaf pine habitats. Under the LLPI, landowners participate in a variety of forestry practices, such as site preparation, forest stand improvement, and prescribed burning to create an optimal habitat for longleaf pine. Benefits of the LLPI include improved soil and water quality, better wildlife habitat and diversity, improved carbon sequestration, and enhanced recreational opportunities and aesthetics. The boundaries of the LLPI in South Carolina cover portions of the Middle Atlantic Coastal Plain and Southeastern Plains, areas that are historic longleaf habitat.

The Shortleaf Pine Initiative (SPI) is a program designed to address the multiple threats facing the increasingly imperiled shortleaf pine forest (Shortleaf Pine Restoration Plan, 2016). Recently, factors such as pine beetle outbreaks, changes in timber management practices, altered fire regimes, and land use changes have contributed to the decline of this specific ecosystem. In 2013, the SPI was formed to address these issues through policy formed by key federal and state agencies from the 22 states affected by the shortleaf pine decline. Shortleaf pine restoration depends on site-specific efforts by regional practitioners and partners to educate landowners interested in restoration on their lands. These efforts include the demonstration of shortleaf pine restoration practices, the sharing of technical information, and the promotion of site-based conservation. This initiative is available throughout all South Carolina ecoregions.

A wildlife-focused conservation initiative within South Carolina is the National Bobwhite Conservation Initiative (NBCI 2015). The NBCI is a 25-state effort to restore bobwhite quail to the whole of America's landscape. The NBCI is focused on developing an ever-evolving strategy to approach bobwhite revival on a landscape scale as opposed to a small-scale, individual farm-based approach as previously utilized. Through the NBCI Technical Committee, representatives from the 25 states can lend their biological, scientific research, and private conservation expertise to the protection and restoration of bobwhite quail. Methods for promoting the reestablishment of bobwhite quail include advancing the establishment of native grasses and flowers along cropland and rural land edges to promote habitat connectivity, converting up to one-third of existing pasture to native grasses beneficial to both cattle and bobwhite, and managing pine and other forests to promote forest habitat connectivity. The NBCI is available to landowners with appropriate acreage and suitable habitat that are deemed to qualify for a NBCI Focal Area, and area where quail populations can be studied more in depth. NBCI provides coordination, design, training, data management, reporting tools, and nationwide outreach. All ecoregions within South Carolina can qualify under the NBCI. For information about the South Carolina Bobwhite Initiative, go to: <https://www.facebook.com/scbobwhites/>

7.1.1.1.2. State Conservation Initiatives and Programs

The [South Carolina Comprehensive Wildlife Conservation Strategy](#) (CWCS) is a major source of the conservation initiatives and programs available within South Carolina to aid in the preservation of species or natural forested resources (SC CWCS 2005). The CWCS provides lists of Habitat Protection Programs and South Carolina Department of Natural Resources (SC DNR) Private Land Programs. Of these state wildlife initiatives, there are multiple programs focused on forestry or wildlife programs. These include [The Heritage Trust Program](#), [Forest Legacy Program](#), [Focus Area Program](#), the Atlantic Coast Joint Venture SC Focus Area Program (including the [ACE Basin Project](#)), [Scenic Rivers Program](#), [South Carolina Conservation Bank Act](#), [South Carolina Land Trust Network](#), [Conservation District Program](#), and the [Red-cockaded Woodpecker Safe Harbor Program](#). These programs should be consulted through the above links to determine whether they apply in each location and circumstance.

The [Indian Creek Woodland Restoration Initiative](#), located in Newberry and Union Counties, seeks to improve habitat for early successional species such as bobwhite quail. This project is focused on the Enoree District of the Sumter National Forest and surrounding private lands. Several organizations are cooperating in this initiative including the USDA Forest Service, the SC Forestry Commission, SC Department of Natural Resources, [SC Bobwhite Initiative](#), National Wild Turkey Federation, Quail Forever, and USDA NRCS.

The [Pee Dee Partnership](#), led by Audubon SC, promotes longleaf pine restoration and bottomland hardwood management in the northeast part of South Carolina. In addition, this group is working to promote “bird friendly forestry” and protection of forestland through conservation easements.

The [Lower Savannah River Watershed Initiative](#) has obtained funding from drinking water utilities to provide technical assistance to forest landowners near the Savannah River from McCormick to the coast. This initiative also provides conservation easements to landowners in order to assist in protecting their lands.

The US Fish and Wildlife Service [Partners for Fish and Wildlife Program](#) provides technical and financial assistance to landowners who are interested in helping improve habitat for certain key wildlife species.

The South Carolina Forestry Commission (SCFC) offers state cost-share programs to those who qualify. Qualifying for these programs requires land that can produce 50 cubic feet of wood per acre per year, which includes most of the land within South Carolina. There are two major cost-share programs available through the SCFC: the [Forest Renewal Program](#) (FRP), which is a strictly state-administered program, and the [Southern Pine Beetle Prevention and Restoration Program](#) (SPB), a federally funded program administered by SCFC. FRP provides financial assistance to qualifying landowners for tree-planting practices approved by the SCFC. The goal of FRP is to encourage and support tree-planting or timber stand improvement on private lands to ensure adequate future timber supplies, as well as to promote benefits such as clean air, clean water, and good wildlife habitat. All counties/ecoregions within the state are eligible for FRP.

SPB is designed to mitigate future forest loss from Southern Pine Beetles for non-industrial private forest landowners through management of pine density using prevention and restoration practices. The goal of these practices is to ensure a pine stand will reach merchantable size prior to the stress of being overly dense develops. As landowners receive financial benefits and vigorous stand growth through these thinning practices, they are incentivized to keep stand density low enough to reduce potential loss from SPB. The prevention portion of the plan involves practices such as reducing stem amount within immature, over-

stocked stands, and thinning by hand or by machine. The restoration portion involves planting activities to return damaged or harvested areas back to healthy forest densities. Eligibility for the program depends on location and the practice being implemented. All counties/ecoregions are eligible for the prevention practices, and all counties/ecoregions are eligible for the restoration practices involving loblolly or hardwood plantings. However, longleaf planting is limited to its historic range and some counties/ecoregions are excluded (Abbeville, Anderson, Cherokee, Chester, Greenville, Laurens, Oconee, Pickens, Spartanburg, Union, and York counties; Blue Ridge ecoregion) while some only have portions that are eligible (Chesterfield, Fairfield, Greenwood, Kershaw, Lancaster, McCormick, Newberry, Richland, and Saluda counties; Piedmont and Southeastern Plains ecoregions). The remaining counties and ecoregions (Middle Atlantic Coastal Plain and Southern Coastal Plain ecoregions) are completely eligible.

Within the America's Longleaf Restoration Initiative, three different Implementation Teams exist across the state of South Carolina: the [Sandhills Longleaf Pine Conservation Partnership](#), the [Sewee Longleaf Conservation Cooperative](#), and the [SoLo-ACE Longleaf Partnership](#). Each of these partnerships has the goal of reestablishing, maintaining, and enhancing the longleaf pine ecosystem using a variety of management practices and collaboration within stakeholders. Each of these local partnerships are composed of a mix of state, federal, and private organizations as well as private landowners within the respective regions. Participating in the various land management activities promoted by these individual partnerships may qualify the landowner for cost-share benefits. Additional information regarding these partnerships can be found at the above links, and these partnerships exist in each ecoregion within the state except for the Blue Ridge and Piedmont ecoregions.

7.1.2. Ecosystem Services

Forests provide ecosystem services to society that are wide ranging and difficult to value. These ecosystem services include clean air and water, carbon sequestration, aquifer recharge, climate resilience, and biodiversity. There are currently few significant markets for these services in South Carolina, but they may develop in coming years. One notable exception is the [Lower Savannah River Watershed Initiative](#) described in Section 4.0. However, lack of financial incentives does not discount the crucial services ecosystems provide us, making ecological maintenance and restoration an important objective for many landowners.

7.1.3. Historical and Cultural Sites

Many private lands contain various historical and cultural resources, also known through ATFS as "special sites." Therefore, forest management activities are often developed to consider and maintain special sites on the property. Landowners may be aware of these sites or their locations may be documented and mapped with federal, state or local agencies and organizations. [Forest resource professionals](#) could discuss known sites with landowners. If the landowner is unaware of any sites or the land is newly acquired, there are many resources available to review potential recorded sites such as the [National Register of Historic Places](#) (NRHP) or the State Historic Preservation Office (SHPO) through the [South Carolina Department of Archives and History](#) (SCDAH) and local historical societies and museums. The [Historical Structures](#) and [Cemeteries](#) layers within the LMP [geodatabase](#) can also be used to provide information on site-specific historic and cultural resources.

In addition, the property can be reviewed on the ground through visual reconnaissance by the landowner or forest resource professional, within a reasonable scale relative to property acreage and accessibility. The

SCDAH and local historical organizations have limited resources, but may be able to assist with locating or interpreting potential significant sites and local preservation laws. Sites listed by these organizations reflect a determination of a site's significance to the history of a community, state or nation and should be protected as required by federal, state or local laws. Non-listed sites of personal significance to the landowner may also be protected.

Landowners and their forest resource professionals are encouraged to make reasonable efforts to locate and protect special sites appropriate for the size of the forest and the scale and intensity of forest management activities. Protection of historical and cultural sites during land management activities can be considered during planning, contract development, monitoring and follow-up inspections. These sites can be designated on the ground with vegetative buffers, flagged/blazed trees, fencing, or signage and communicated to contractors and sub-contractors.

Landowner considerations for determining whether to designate an unlisted site may include:

- Significance:
 - Site has made a significant contribution to the broad patterns of our history;
 - Associated with the lives of significant persons of the past;
 - Embody distinctive characteristics of a type, period or method of construction, or represent the work of a master, or possess high artistic values, or represent a distinguishable entity whose components may lack individual distinction;
 - Yielded or likely to yield information important in history or pre-history
- Age: Minimum 50 years-old
- Integrity:
 - Site must retain its historical physical integrity with its character-defining features still present.
 - Building, structure or landscape feature must be relatively unchanged.
 - Archeological site must be relatively undisturbed, with its patterns and layers of artifacts relatively intact.
 - Traditional cultural site must be recognizable to today's affiliated cultural group, evidenced through tradition and still used or revered today.
- Personal Significance: such as a location, structure or artifact with a family importance or meaning.

Special sites of biological and geological significance and sensitivity may be identified through consultation undertaken related to the identification of threatened or endangered species and natural communities. Cultural and historical resources can be mapped and marked on the ground to aid general protection, documentation and monitoring efforts. However, some landowners may wish to keep these sites unmarked and unmapped to avoid attracting attention that could lead to vandalism, theft or degradation.

Historic, cultural, and special sites may include:

- Native American burial grounds, camps, middens, mounds etc.
- Historic dwellings, structures, foundations, barns, wells, cattle dipping vats, ruins, cemeteries, bridges
- Geological formations, sinkholes, limestone bluffs or outcroppings, caves/entrances, spring heads, springs, etc.
- Rare plant populations, pitcher plant bogs, champion trees, bear dens, etc.

7.1.4. Recreation

South Carolina's geography and variability of different habitats within the state, ranging from the coastal "Lowcountry" to the foothills of the Appalachians, lend itself to providing a wide range of recreation opportunities through its natural areas. South Carolina's forests are popular places to recreate due to their unique topography, biological diversity and the wide range of potential activities. Landowners can enjoy personal and family recreational use or lease their land as a means of revenue generation. If leasing land for hunting, it is important to purchase liability insurance for the property to protect your liability in the event of an accident. Potential [recreation activities](#) include:

- Hunting and leases
- Bicycling
- Fishing and leases
- Equestrian
- Off-highway vehicles (OHV) and leases
- Camping
- Eco-tourism and leases
- Environmental education
- Wildlife viewing and birding
- Geocaching
- Hiking
- Paddling

7.1.5. Aesthetics

From a towering pine stand with a sea of grasses to a lush, mixed bottomland hardwood forest to the unique landscape of Carolina bays, the wide range of forest types, topography and aquatic features throughout South Carolina provide unique forest aesthetic values. The forests themselves vary from open, pine-dominated rolling hills to dense cypress ponds. Northwestern South Carolina boasts hardwood forests more fitting of the Appalachian Mountains as you move toward the north Georgia/North Carolina borders. These dense forests are composed of many northern species, providing a different aesthetic than the southeastern South Carolina lowlands, where the cypress lined rivers and ponds have their own prehistoric beauty.

South Carolina is quite diverse in its topography due to its stretching from coastal lowlands to the Appalachian foothills. It has rolling sand and clay hills in the Piedmont, steep-head spring ravines, slope forests and high river bluffs. These features allow for exceptional forest views in a relatively flat state. Various aquatic features such as forested wetlands, lakes, ponds, rivers, streams, springs, pocosins, and Carolina bays are major visual highlights of the state's forests. These are present naturally throughout the region and add character to a property; so much so that many landowners choose to enhance their property's aesthetics by creating man made ponds and waterbodies. These forest aesthetic considerations not only provide beautiful views but also a sense of privacy, adventure, and landowner pride.

7.1.6. Forests of Recognized Importance (FORI)

Forests of recognized importance (FORI) represent globally, regionally, and nationally significant large landscape areas of exceptional ecological, social, cultural, or biological values. These forests are evaluated at the landscape level, rather than at the stand level, and are recognized for a combination of unique values, rather than a single attribute. FORIs may include landscapes with exceptionally high concentrations of one or more of the following:

- Protected, rare, sensitive, or representative forest ecosystems such as riparian areas and wetland biotopes.
- Areas containing endemic species and critical habitats of multiple threatened or endangered plant and animal species, as identified under the Endangered Species Act (ESA) or other recognized listings.
- Recognized large-scale cultural or archeological sites including sites of human habitation, cities, burial grounds, and in situ artifacts.
- Areas containing identified and protected water resources upon which large metropolitan populations are dependent.
- Areas containing identified unique or geologic features including geysers, waterfalls, lava beds, caves, or craters.

While landowners are encouraged to contribute to or support the values that led to the FORI designation of the area, the FORI designation does not compel the landowner to take any actions.

7.1.6.1. FORI Designation within Region

In the United States, because of their significance, FORIs have generally been identified and protected by federal or state governments or are under conservation easement by an environmental nonprofit organization. There is currently no state or federal agency that regulates FORIs on private forestlands in the United States. Several conservation organizations have identified areas that they believe are of exceptional status, yet there remains no single central clearinghouse of information regarding such forested landscapes.

To support and facilitate identification of these resources within this project, AFF worked with the Support Committee to develop a list of FORIs within the state while consulting the South Carolina's Forest Action Plan and area conservation priorities. The following forest landscapes were identified for the LMP, by these stakeholders, based on the combination of their unique attributes, consistent with the definition of FORI under ATFS.

7.1.6.1.1. Public Lands

Due to their recognized conservation priorities for protecting habitat, biodiversity, water resources, cultural sites, and unique geologic features, all area federal and state protected public lands are considered FORIs within this LMP. This designation includes state forests, state parks, national forests, national parks, water management areas, wildlife management areas, and wildlife refuges. The state and federal public lands within the region are included in the [FORI spatial layer](#).

Landowner Actions to Protect FORIs

For family landowners, a likely scenario is that their property is adjacent to a state or federally protected area and identified as a FORI at a landscape scale. Landowners should consider the impact to a neighboring FORI and opportunities to support consideration of specific values or attributes when planning and implementing activities on their forest property. Given the size and scale of family ownerships eligible for ATFS certification, landowners may be limited in their abilities to significantly impact FORI presence and quality through management at the small scale.

Management activities on or adjacent to an identified FORI should seek to contribute to or support the values that led to the designation of the area. While landowners are encouraged to contribute to or support the values that led to the FORI designation of the area, the FORI designation does not compel the landowner to take any actions.

During the ATFS inspection process, an ATFS Inspecting Forester shall confirm the presence or absence of a FORI on the property. The ATFS Inspecting Forester should also identify any efforts the landowner is making to support the values of the identified FORI within the 004 Form.

7.2. Forest Type-Specific Forest Resources

7.2.1. Fish & Wildlife

The forests and associated aquatic ecosystems of South Carolina provide habitat for a wide array of game and non-game fish and wildlife, including several imperiled species ([Table 2](#)). These forests can be managed in a way that enhances, restores and protects the valuable habitats these species call home. These species may be managed for various objectives such as [conservation](#), [legacy planning](#) or [recreation](#). Present listed species can be documented, mapped and monitored.

The [SC BMPs for Forestry](#)

http://www.freshfromflorida.com/content/download/61100/1270718/WildlifeBMP_final.pdf compile strategies and considerations for managing and protecting these species and their habitat during silvicultural operations. For example, marking a rare plant or animal area with flagging, paint or signage to protect during harvest operations, regular active monitoring and following up with post-harvest inspection(s). The [SC BMPs for Forestry](#) manual also considers fish and wildlife conservation in relation to silvicultural activities.

Pine forests provide habitat to hundreds of game and non-game species including bobwhite quail, wild turkey and deer. They are also home to several rare species including: gopher tortoise, bald eagle, frosted flatwoods salamander, Indiana bat, and red-cockaded woodpecker ([Table 2](#)). Hardwood forests also provide habitat for their own collection of game and non-game species.

7.2.2. Timber Products

The merchantability of a stand of trees, whether planted or natural, pine or hardwood, will depend on acreage and volume, local timber markets and mill product specifications. The [LMP Geodatabase](#) can be utilized to locate and contact local mills and calculate haul distance. Mills in South Carolina, Georgia and North Carolina purchase these products from South Carolina landowners.

The value of timber trees is based on the value of the products that can be made from them. This is dictated by size (height and diameter), species, and quality of the trees. Product classes are generally expressed in terms of diameter measured at breast height (DBH) and are given below:

- **Pulpwood:** 6-9" DBH. Pulpwood trees are chipped into small pieces, chemically treated, and made into paper. Pulpwood is measured in tons or standard cords.
- **Superpulp:** This is an unofficial designation used to describe pulpwood-sized pine trees from which one 2 x 4 board could be cut. Superpulp is more valuable than regular pulpwood, but markets for this product are not always available. Another name for superpulp is "canterwood."
- **Palletwood:** This is an unofficial designation for low-quality hardwood timber that is not good enough for lumber, but can be sawed into slats for pallet-making. Palletwood is sometimes called "skrag."
- **Chip-n-saw:** 10-13" DBH. By using a combination of techniques, these mid-sized trees produce chips for pulpwood as well as small dimension lumber. Chip-n-saw is measured in tons or standard cords. Value is heavily dependent on tree quality.
- **Sawtimber:** 14"+ DBH. Trees are cut into lumber. Waste material is converted into chips for fuel or paper production. Sawtimber is measured in tons or board feet. Value is heavily dependent on tree quality.
- **Pole and Piling:** 10-20" DBH. Poles and pilings are used to hold vertical loads and must be straight. Eligible trees have straight, cylindrical trunks free of limbs and defects for at least 32', and trunk sweep should not exceed 1" for every 10' of trunk length. The demand for poles and pilings and their sizes is highly variable, and ultimately, the buyer of those product classes determines whether a tree is a pole or piling tree. For valuation purposes, most pole and piling quality trees are considered sawtimber.
- **Veneer:** 16"+ DBH. By means of a large lathe, the tree is converted into continuous sheets of thin wood. This is used in the manufacture of plywood and furniture, depending on the type of tree. Veneer is measured in tons or board feet. Value is heavily dependent on tree quality. For valuation purposes, most veneer quality trees are considered sawtimber.

Timber, like any other commodity, experiences price fluctuation according to the laws of supply and demand; prices may vary significantly from one part of the state to another. The price paid for any product class also varies according to quality.

Terminology complicates the understanding of timber value. In South Carolina, there are two accepted, quantifiable standards for measuring pulpwood and chip-n-saw: standard cords and tons. A standard cord is a stack of wood measuring 4' x 4' x 8' (128 cubic feet); a ton is 2000 pounds of raw wood, including bark. Occasionally, pulpwood volume is quoted by the "unit." This is an undefined quantity; it can mean just about anything. Timber owners should insist that any pulpwood quote is based on standard cords or tons.

Sawtimber is even more complicated in its nomenclature. There are three recognized methods of computing the number of board feet in a given tree. Called "log rules," these are tables estimating the amount of lumber that can be cut from trees of various sizes. The Scribner Log Rule is the commonly accepted measurement standard for pine sawtimber in SC; the Doyle Log Rule is frequently used to estimate hardwood timber. The third rule, International Quarter-Inch, may actually be the most accurate but has never gained much acceptance in the state. Sawtimber volume is usually quoted in thousands of board feet (MBF).

Any of the three log rules are legal, but all give a different estimate of timber volume in a given tree. The seller should understand that an offer of \$200 per thousand board feet on the Scribner rule usually returns more money than \$200 per thousand board feet on the Doyle rule. There is no easy way to convert among the three.

The price paid for standing timber is called “stumpage.” This is the amount the landowner is paid in a timber sale. Stumpage will be expressed as dollars per cord, dollars per ton, or dollars per thousand board feet. The amount the timber brings at the mill is called the “delivered price.” The delivered price will be higher than the stumpage price because it includes the cost of logging and hauling.

There are some standard conversion factors for products. Here are a few commonly used equivalents:

<p>Pine Pulpwood 5350 pounds = 1 cord* 2.675 tons = 1 cord</p>	<p>Mixed Hardwood Pulpwood 5800 pounds = 1 cord* 2.90 tons = 1 cord</p>
<p>Pine Sawtimber 1000 board feet = 2.8 cords 7.50-7.75 tons = 1000 board ft</p>	<p>Hardwood Sawtimber 1000 board feet = 3 cords</p>

**Standard established by SC Code of Laws 39-9-130*

An 18-wheel truck/trailer can haul about 25 tons of timber. This is the equivalent of about 9.3 standard cords of pine pulpwood or chip-n-saw. If the load is sawtimber or veneer size, the truck can haul about 3.3 MBF.

Pine forest products

Timber is considered **pre-merchantable** if it is too small in diameter and/or height for one of the products above. All the major timber product groups can be harvested from all the different pine forest types including pulpwood, chip-n-saw, sawtimber and poles. These pine forests also allow for fuelwood harvests, especially utilizing natural regeneration and hardwood reduction treatments. With its fast, early growth, loblolly pine is sometimes managed for lower value, short rotation products such as pulpwood. Each pine species can generally be managed for longer rotation products such as sawtimber, poles, and pilings/veneer. All the major timber product groups can be harvested from pine-hardwood mixed forests.

Hardwood forest products

All the major timber product groups can be harvested from Pine-Hardwood Mixed, Upland Hardwood, and Bottomland Hardwoods forest types including pulpwood, chip-n-saw, sawtimber and fuelwood. Forest age and site quality have a strong effect on which products can be produced, with older forests growing on good soils having the most potential of producing the most valuable products. Bottomland Hardwood forests are sometimes managed for hardwood pulpwood, especially if hardwood pulpwood prices are high. Mature Pine-Hardwoods Mixed forests, where hardwood makes up the understory, will produce hardwood pulpwood along with pine sawtimber

The following timber product groups can be harvested from Tupelo-Cypress Mixed forests: hardwood pulpwood, cypress mulch and sawtimber and fuelwood. This forest type is commonly managed for lower value products such as hardwood pulpwood and cypress mulch.

7.2.3. Non-Timber Forest Products

Many non-timber forest products (NTP) opportunities exist within pine forests, including pine straw (slash and longleaf pine) silvopasture (all pine forests), bee-keeping (all pine forests) and saw palmetto drupe harvests (all pine forests). NTPs exist to a certain scale within hardwood forests as well. Pine-hardwood mixed, upland hardwood, mixed floodplain, tupelo-cypress mixed, and cottonwood, sycamore, birch all provide opportunities for bee-keeping and fruit harvests, while tupelo-cypress mixed forest types provide opportunities for the collection of cypress knees as well.

Pine-specific forest types

Pine straw

Longleaf pine straw is the most valuable and desirable as it produces long, resilient, attractive needles ideal for landscaping. Pine straw raking for landscaping material is the most common NTP market in the region. It often generates \$100-\$150 per acre per year or more and can be conducted while the timber is still pre-merchantable, providing landowners with early returns on their stand establishment investment (i.e. site preparation and reforestation costs). Raking is generally initiated at crown closure (year 10) and often ceases following first thinning (year 20). This period of raking usually coincides with the stand's crown lifting via shade. If landowner objectives are focused on maximizing revenue, they may wish to forego thinning and rake straw beyond economic or biological thinning age, clearcutting for pulpwood at age 22-25 and starting over. If landowner objectives are varied and involve thinning, the stand should be thinned at economic or biological thinning age (year 20-22) to promote proper stand development.

Traditional pine straw raking reduces or eliminates the native groundcover with annual herbicide and mowing and removal of coarse woody debris. This eliminates impurities being mixed in with the pine straw and allows for efficient raking. The result is a monoculture of the pine species, drastically reducing the quality of wildlife habitat. However, a more conservation-oriented form of pine straw management has been developed which entails raking the pine straw from the top of native groundcover and avoids frequent herbicide and mechanical treatments (NWF 2015), which might be a better fit for landowners balancing pine straw revenue with timber, wildlife and aesthetic objectives. This approach will likely not include annual raking and may generate less revenue, but splitting a stand in two sections and raking one section per year is one approach to gain annual revenue. Pine straw stands are often fertilized to produce more pine straw, promote tree growth and avoid depleting soils. Pine straw raking can be rewarding, yet requires a lot of work to be successful. Planning and site selection begins prior to stand establishment.

Visit "[Straw Raking in Southern Pine Stands and Fertilization Recommendations](#)" and "[Lifting Longleaf Pine Straw: An Option to Balance Income and Wildlife](#)" for more information.

Silvopasture

All pine habitat is conducive to silvopasture. Silvopasture is an agroforestry practice combining livestock, forage and timber management within the same land management unit (Hamilton 2008). This system provides landowners various combinations of options to manage forage (hay, etc.), livestock (cattle, etc.)

and pine straw for short-term revenues while managing their timber for high-value products (poles and sawtimber) on longer rotations. Properly managed silvopasture systems also allow farms to be more profitable by diversifying revenue sources and cutting feed costs. However, landowners should be willing and able to actively manage the forage, livestock and timber components.

The open forage areas within the management unit allow for biodiversity, enhancing cool season grasses, while also allowing for warm season grass production. The areas with timber provide shade to livestock. This open, relatively low density stand structure enhances aesthetics, property values and recreational opportunities. This system also promotes wildlife populations and provides habitat for wild turkey and quail. The combination of timber and quality forage also prevents erosion and improves water quality and hydroperiod.

Silvopasture provides economic security by reducing risk through diversification of products. However, prior to establishing a new silvopasture system, local land-use, cost share and tax regulations should be reviewed. Forestry and agriculture may have different land use and zoning regulations which may be tied to separate tax structures. Some states consider silvopasture cost sharable through Environmental Quality Incentives Program ([EQIP](#)).

Silvopasture is generally easier to establish in existing timber stands, which already have trees with good form that can be thinned or clearcut to provide corridors of adequate width that support forage production. Converting existing pastures can be difficult when having to exclude existing livestock from the developing stand. Silvopasture supports less livestock than pasture, since it is simultaneously supporting viable timber and livestock production.

Visit [Silvopasture: Establishment & management principles for pine forests in the Southeastern United States](#) for more information ([Hamilton 2008](#)).

Hardwood-specific forest types

Cypress knees

Tupelo-cypress mixed forests produce knees that can be cut and used for art and craft purposes. This is non-commercial and on a small-scale

Pine and hardwood forest types

Honey

Beekeeping and **honey** production are common within pine forests. Honey production can provide annual short-term revenues. Landowners can produce and sell honey themselves, sell their honey to larger producers and distributors, lease their lands to honey producers, or conduct beekeeping as a hobby for personal consumption. Properties with a diverse stand composition, in terms of overstory and understory species and uplands and wetlands, can potentially generate honey revenue nearly year-round. Upland and wetland forests are marketable for apiary leases; however, this is not particularly lucrative and often done by bartering honey for leased land.

Beekeeping and honey production, especially the introduction of bees into the state, is covered by the South Carolina Code of Laws (<https://www.scstatehouse.gov/code/t46c037.php>). In order to protect this industry

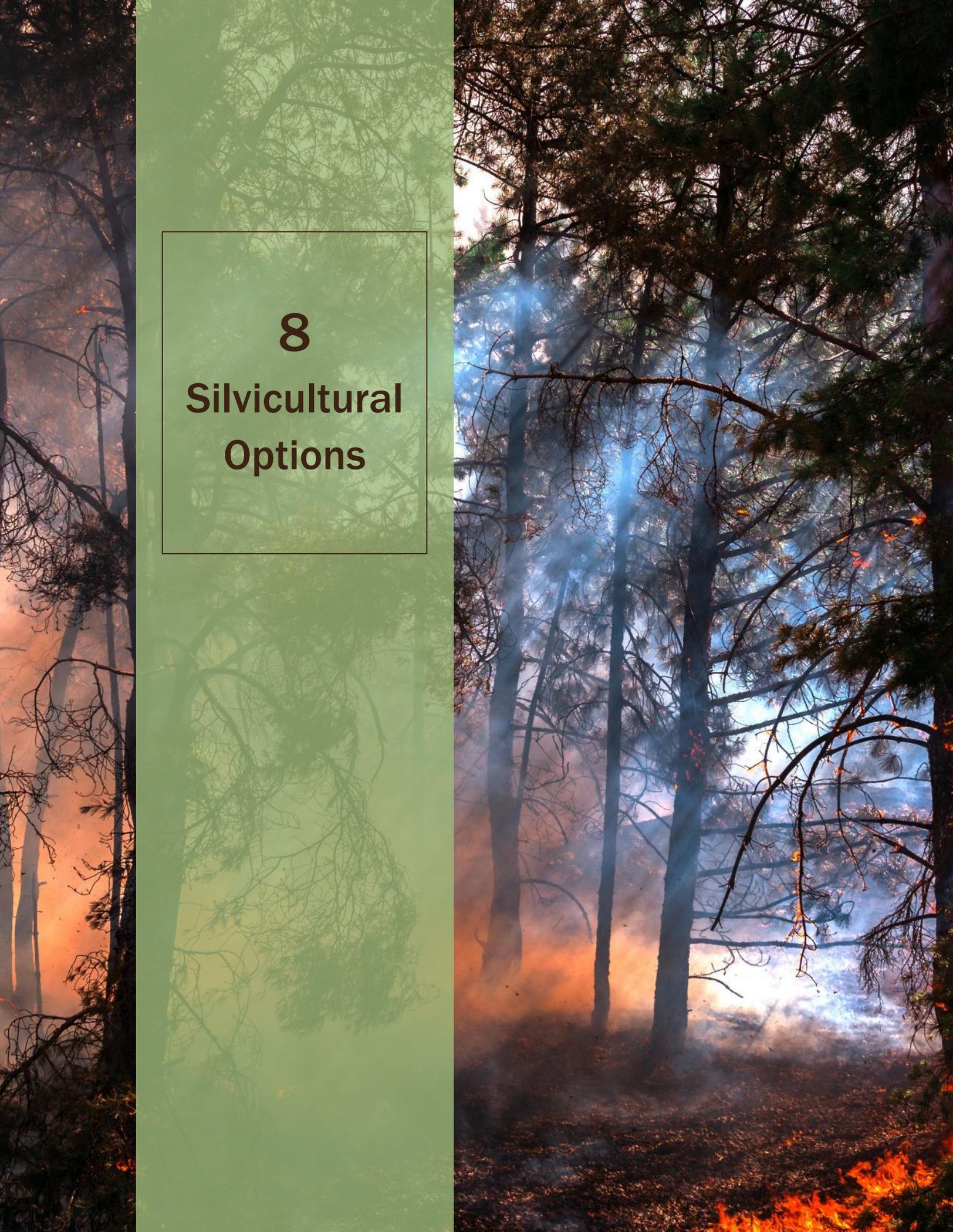
from pests and unwanted species of honey bees, they require inspections of new colonies through Clemson University. Additional resources and professional association affiliation can be found through the [South Carolina Beekeepers Association](#).

Fruits

Hawthorn (*Crataegus* spp.) can be collected from mixed bottomland and upland forests as a group and is often made into a jelly and sold commercially. Blueberry, blackberry and other native fruits grow in several forest types, but are not commercially harvested from forest settings. However, landowners may enjoy harvesting small quantities from their land for personal use. Other Non-Timber Forest Products are given below:

Other Current and Potential NTFP Markets

- Medicinal Native Plants
 - St. John's Wort
- Other Edible Products
 - Nuts
 - Mushrooms
- Ornamental Products
 - Spanish Moss
 - Pine Tips for Garlands
 - Pine Cones
 - Grapevines
 - Burl and Crooked Wood
- Landscape Products
 - Pine Bark Mulches
 - Palm Trees



8 Silvicultural Options



8. SILVICULTURAL OPTIONS

8.1. Timber Harvest

The following silvicultural and land management tools are available to South Carolina [forest resource professionals](#) to meet various [landowner objectives](#) and utilize forest resources. These are the common methods used in this region but there may be others available. One or a combination of these tools may be used to meet single or multiple objectives. Landowner objectives and budget ultimately determine which tools may be utilized. Local contractor availability, timber and [NTFP](#) markets, project scale, local regulations, site conditions, local climate, the degree of planning and scheduling, and other factors also influence the forester and landowner decision making process when determining which tools to utilize to efficiently and effectively meet landowner objectives. Before conducting a timber harvest, it's imperative to have the timber basis established so that capital gain taxes only apply to the net gains, not the gross timber sale.

The [SC BMPs for Forestry](#) compile voluntary guidelines, strategies and considerations for managing, enhancing and protecting: timber and [NTFP](#) resources, rare plant and animal species/habitat, aquatic ecosystems and air and water quality, during silvicultural operations. [SC BMPs for Forestry](#) apply to: timber harvest, site preparation, reforestation and forest operations (roads, water control structures, etc.) activities. Historical and cultural resource protection and [recreation](#) management are also considered during planning and active silvicultural operations.

The general descriptions of each specific South Carolina [forest type](#) provide information related to their specific harvest and profitability information. Each forest type is examined for its preferred management method (i.e. even-aged), length of growth rotation, site suitability for commercial species, and further options beyond commercial harvesting (i.e. aesthetics, wildlife). Below are descriptions of each type of silvicultural activity and how each activity is applicable to the different forest types within South Carolina. In instances where there is no difference between multiple different forest types in respect to the silvicultural practice, only the forest types that differ will be further explained.

8.1.1. Thinning

Pine Forest Types

Thinning is a primary land management tool used in South Carolina to meet various objectives such as [economic return](#), [aesthetics](#), [wildlife](#), and [restoration](#). The type and timing of thinning are dependent on several factors including landowner objectives, market conditions and stand and site conditions. This is a stand-specific determination that can be made by a forester. There are also site-specific [SC BMPs for Forestry](#) related to thinning harvests, particularly in wetlands and streamside management zones.

Several types of merchantable thinnings are utilized in pine stands in South Carolina. These partial harvests may involve row thinning, single tree selection, or a combination of both. Due to a lack of equipment mobility, individual rows must be removed during first thinnings to allow equipment access. The most common row thinning method for first thinnings is a third row thinning. Single-tree selection via logger-selection or a logger-select thinning, also known as "operator select," of the residual rows is also common during first thinnings. The most common used method for first thinnings is a combination of both, the "fifth row and

select” method, in which the fifth row is removed to provide access to logging equipment, and then the lower quality trees in the leave rows are removed in order to reach the target stand density.

Some first thinnings in planted pine, and most thereafter, are thinned through marked selection or marked-select thinning by a forester. Foresters also mark 1+ acre demonstration areas on logger-selection first thinnings to walk through and discuss with logging crews how the stand will be thinned.

Single-tree selection in combination with row thinning is preferred over straight row thinnings without selection. Whether marked or logger-selection, single-tree selection improves forest health, aesthetics and promotes higher net growth. A straight row thinning reduces competition for the trees adjacent to take row but leaves inferior cull trees throughout stand.

Natural pine stands are typically thinned like planted stands, but instead of rows being removed, strips referred to as corridors are removed. Depending on the initial and desired residual densities, first thinnings in young, over-dense stands will usually have 12' wide corridors removed for every 12-24' wide corridors of leave trees. A 40% corridor thinning will have 12' wide corridors removed for every 18' wide corridor of leave trees. Operator select is usually only done in second thinnings and later, or within older stands in combination with a corridor thinning. In older, sawtimber-sized stands, 12-20' wide corridors are removed every 50-60' and then operator select is done in between. Corridors and take trees are sometimes marked by a forester in older stands. Marking natural stands allows more control over residual quality due to their variable nature.

Basal area is a term used in forestry to measure stand density, which is the cross-sectional area of trees measured at breast height (4.5' above ground) in square feet per acre. Knowing the density helps foresters know what the thinning rate should be to meet the landowner objectives. If wildlife, aesthetics or biodiversity are primary objectives, stands should be thinned to a lower density than if economic return is the main objective. If managing for multiple-uses, a moderate density can be used.

Most stands managed for timber production are maintained between 80 and 120 sq ft of BA per acre. Once the stand reaches 120 BA it is thinned to 80 BA, which is repeated for each subsequent thinning until the final harvest. When managing for poles and pilings, this range is usually 90-130 BA per acre, and for wildlife this range is usually 60-100 BA. Maintaining higher densities ensures straighter trees and maintaining lower densities ensures sunlight reaching the forest floor to benefit wildlife. Stands having densities greater than 120 BA are more at risk to SPB.

Maintaining healthy crown ratios (crown length/total length) is important to consider as well. Most first thinnings are done when the average crown ratio is 50% and then are maintained with an average crown ratio of 33% when moving forward. Natural, over-dense pines stands greater than 20 years old with average crown ratios less than 20% should be considered for a final harvest, since the residual trees likely will not have enough crown to benefit from the thinning.

Planted loblolly pine during timber management on productive sites generally requires a first thinning around age 13-15, a second thinning around age 18-22, and a final harvest beginning around age 30-32. The first thinning will usually come sooner for wildlife management and later for poles and pilings, and subsequent thinnings generally take place every 5 to 7 years in planted and natural stands.

Planted longleaf pine, because of its slower growth, generally requires a first thinning around age 20-24, a second thinning around age 30-34, and a final harvest beginning around age 45-50. Many landowners tend to continue pine straw raking in planted longleaf pine stands beyond the biological and economic thinning ages. This decision can have negative impacts on stand development in terms of [forest health](#) and timber quality and value.

Young pine stands overstocked with natural regeneration (>1,000 stems per acre) should have a pre-commercial thinning by hand prior to age 10. The SCFC's SPB Program offers cost-share assistance for these thinnings. For young, overstocked stands growing on productive soils and greater than 40 acres in size, a corridor thinning or fuelwood chipping at age 15-20 can take the place of a pre-commercial thinning. The "economies-of-scale" and available markets together play a large role in these thinnings.

Releasing the understory at a faster rate than the overstory may occur when a stand with a heavy understory and poor crown ratio are thinned too heavy. Prescribed burns and understory herbicide releases are usually conducted in between thinnings to control the understory from being released.

Pulpwood-sized stands with poor crown ratios that have been recently first-thinned below 70 BA are most susceptible to ice storm damage. To minimize the risks, stands can be thinned to a higher BA, or thinned in early spring so the residual stems can form compression wood over the summer making them more resistant to an ice storm the following winter.

Many landowners may choose not to thin mature even-aged and two-aged pine stands as their desired future condition has been met. They enjoy the benefits of this mature stand structure such as high-quality [wildlife habitat](#), [aesthetics](#) and [recreational opportunities](#). Other landowners may choose to occasionally lightly thin their mature pine for revenue, forest health and maintaining overstory composition. See the [forest health](#) section for the risks associated with managing mature pine.

[Natural regeneration harvests](#) are discussed in the [reforestation](#) section.

Upland Mixed Hardwood-Pine Forest Type

Thinning shortleaf pine/hardwood mixed and loblolly pine/hardwood mixed forests is not commonly practiced in South Carolina. However, thinning can be conducted in these mixed forest types.

Thinning from above can be used as a [natural regeneration](#) method.

Thinning is a primary land management tool used to meet various objectives such as revenue, aesthetics, wildlife and restoration. The type and timing of thinning are dependent on several factors including [landowner objectives](#), market conditions and stand and site conditions. This is a stand-specific determination that should be made by a forester. There are also site-specific [SC BMPs for Forestry](#) related to thinning harvests, particularly in wetlands and streamside management zones.

Mixed pine/hardwood stands can be thinned using **marked selection** by a forester. Marking these stands allows for more control over thinning density and quality due to their variable nature. Desired residual species ratio should be considered during planning. Logger operability should be considered during marking.

Thinning from below, utilizing a hardwood pulpwood or fuelwood chipping harvest, is sometimes done in loblolly pine/hardwood mixed forests, since the hardwoods are primarily in the understory. Many landowners may choose not to thin pine/hardwood mixed forests as their stands are already in desired future condition. They enjoy the benefits of this forest type's structure such as high-quality wildlife habitat, aesthetics and recreational opportunities. Other landowners may choose to occasionally lightly thin their stands for revenue, forest health and maintaining overstory composition.

Natural regeneration harvests are discussed in the reforestation section.

Upland Hardwoods Forest Types (Upland Hardwoods, Maritime Forests)

Thinning upland hardwood forests is not commonly practiced in South Carolina, but certain high-quality hardwood stands such as desirable oak can be selectively-thinned (South Carolina SFI Implementation Committee 2015). Thinning these stands should be done cautiously, since exposing trunks to high levels of sunlight from thinning may cause epicormic sprouting, degrading the value of these trees for sawtimber.

Bottomland Hardwoods Forest Types (Tupelo-Cypress Mixed, Carolina Bay)

Thinning bottomland hardwood is not commonly practiced in South Carolina. They produce low value products and it is not economically viable to manage these forests through thinning.

8.1.1.1. Edge Feathering

Edge feathering is a technique used within thinning to create forest edges that gradually transition from forest to the surrounding habitat, especially if the adjacent land is managed land such as cropland or pasture. Within this practice, three different zones are created with each containing increased levels of thinning (75% thinned, 50% thinned, 25% thinned) moving from the forest edge into the forest (Habitat How-To's 2019). This method of thinning creates a gradual transition from larger trees in the forest to smaller grassy vegetation, while creating habitat for various wildlife species that need brushy cover for nesting. This method is best applied to edges with a southern or western aspect that receive direct sunlight. A broader edge between forest and pasture/cropland gives more room for these species to establish a home and is a major technique utilized in bird-friendly forestry.

8.1.2. Clearcut

Clearcutting is a standard silvicultural practice in managing shade intolerant pine as well as hardwoods for timber and other objectives. In most South Carolina timber markets, on most soils, timber revenue is maximized through long-rotation, even-aged management for pulpwood and sawtimber production. Uneven-aged management is used mainly in longleaf pine stands and hardwoods, or stands that are in aesthetically-sensitive areas. Clearcuts are utilized in planted or natural stands of pine, hardwood and cypress. When clearcutting, hardwoods coppice (regenerate from the stump) and should be cut above the stem mean water mark to allow for successful regeneration.

Another primary use of clearcutting is for salvage harvests which are discussed in this section.

A clearcut can also be utilized for species conversion within a timber stand to meet various objectives or may reflect a change in objectives. Many pine-hardwood mixed forests were historically dominated by longleaf, shortleaf, or loblolly pine. Clearcutting can be used to remove offsite pine-hardwood mixed stands

and replant with the appropriate pine species. The common South Carolina example is converting off-site pine and hardwood species back to longleaf pine. Another may be clearcutting longleaf and reforesting with a more productive species like loblolly pine on certain spodic soils or loblolly on certain clay soils.

There are site-specific [SC BMPs for Forestry](#) when using clearcuts, particularly in wetlands and SMZs. The size and shape of clearcuts should be considered if [wildlife](#) and [aesthetics](#) are also objectives. Also, timing and seasonality are crucial when considering clearcutting in wetlands or wet upland sites. Mat logging is a technique utilized to minimize soil and hydrological impacts in these hydric forest types (Bottomland Hardwoods). Non-clearcut buffers or “beauty strips” can be used along roads and highways to reduce negative aesthetics associated with clearcuts. Timing and seasonality are crucial in wetlands and wet upland sites.

8.1.2.1. Patch Cuts

Patch cuts are a form of clearcutting that cuts groups (patches) of trees in an individual stand (USDA Reforestation Glossary 2019). This method can help to create varying habitat within a forest stand while promoting natural regeneration within the small openings in canopy cover (Zielke and Bancroft 1999). All these small patch cuts will then be managed as individual stand units.

8.1.3. Chipping/Pellets

Another form of timber harvest in South Carolina is chipping. Material is felled and skidded conventionally, then inserted into an industrial chipping machine at the loading deck, with chips being hauled to the mill rather than tree-length logs. Both pre-merchantable and merchantable pine, hardwood and shrub materials can be chipped. The maximum diameter of the material to be chipped varies by chipping machine and species.

Both hardwood and pine tree-length pulpwood can be hauled as clean chips, which often have a higher stumpage price than pulpwood. Clean chips are derived from nearly pure, living wood that has already been debarked and contains very little vegetation and debris mixed in. Hardwood and pine clean chip loads must be sorted. Young merchantable pine clearcuts can be clean-chipped.

Fuelwood chips can be derived from the same size and species of material as clean chips but include dead and living vegetation such as needles, leaves and limbs. A load of fuelwood chips can contain a mix of hardwood, pine and shrub materials. Fuelwood chips are burned at mills and biomass energy plants to generate electricity and are the lowest value timber product in South Carolina markets. They are also processed into pellets and shipped to European markets and burned for energy production. Young merchantable pine clearcuts can be clean-chipped as fuelwood chips

Fuelwood chipping is commonly used in low-value, hardwood, clearcuts, land clearing operations, or other situations where it is not feasible to conduct a traditional timber harvest. These operations may break-even or generate a small amount of revenue from fuelwood, but more importantly, they can meet other objectives, such as hardwood reduction and removal or site clearing. Chipping can also be used in place of a pre-merchantable thinning to reduce natural pine regeneration or tree density in overly stocked planted pine stands. This avoids pre-merchantable thinning costs and will generate revenue or break-even. Fuelwood or

clean-chipping can be used where a very debris-free post-harvest site is required. For example, fuelwood chipping can be used as part of [site preparation](#) for groundcover restoration projects.

Pine and hardwood stands present opportunities for fuelwood chipping operations such as reducing overstocked natural regeneration in mature, two-aged stands or hardwood reduction/adjusting hardwood ratios. Within the hydric Bottomland Hardwoods forest type, fuelwood chipping operations may serve as an alternative to hauling tree-length.

8.1.4. Salvage

Salvage harvests are valuable tools that help make the most of difficult circumstances. They are commonly utilized to harvest timber following varying degrees of catastrophic natural disasters. These include wildfires, climatic events such as hurricanes, and forest health issues such as southern pine beetle outbreaks.

The primary purpose of a salvage harvest is to utilize as much of the damaged timber resource as possible prior to mortality and a complete loss of merchantability. Salvage is also used to maintain or enhance [forest health](#) and [aesthetics](#). Sometimes secondary objectives become primary or attainable following a catastrophic event. For example, restoration and recreation goals may get realigned, allowing for good management accomplishments to arise out of what appears to be a completely bad situation at the time.

Salvage operations typically involve [clearcuts](#), but that is not always the case. A salvage operation can entail evaluating an impacted stand and thinning the damaged timber using marked-selection, while maintaining the relatively healthy trees. There is always a forest health risk involved in the determination to clearcut or thin damaged timber. This determination is situation and site-specific and should be made following careful evaluation.

Salvage harvest operations can be used in pine stands as well as hardwoods. A variety of natural and anthropogenic factors could cause the need for a salvage harvest. For example, a hurricane may wind-throw an entire stand that would need to be salvaged, southern pine beetle outbreaks may require a clearcut for salvage, or an improper prescribed burn may cause mortality.

8.2. Reforestation

Reforestation is a core tool of sustainable forestry. The goal is to successfully establish a species appropriate for the site, while meeting landowner objectives. This process involves careful planning and selection of: [artificial or natural regeneration](#), species, [seedlings](#), density, [site preparation](#), [planting method](#) and [release](#). Each of these elements of reforestation are dictated by: [landowner objectives](#), site conditions, current and forecasted timber markets, budget and other factors.

The Upland Hardwoods and Bottomland Hardwoods forest types are not artificially regenerated in South Carolina at a significant scale worth discussion.

8.2.1. Artificial vs. Natural Regeneration

A selection between artificial and natural regeneration must be made during the stand and property-level silvicultural planning process. This selection is driven by landowner objectives and site-specific circumstances. However, there are pros and cons to each reforestation strategy ([Table 6](#)).

Table 6 Comparison summary of artificial and natural regeneration methods of reforestation

	Pros	Cons
Artificial	More productive timber management	More expensive: seedling and planting costs
	Better stand development: form, growth	Rows may decrease aesthetics during early rotation
	More control over seedling quality through improved genetics: growth rate, disease resistance, form	More heavy equipment entry required (soil compaction, rare plants)
	Control over planting density and spacing	
	More conducive to high production management	
	Less likely to require pre-merchantable thinning (cost)	
	Can use for species conversion i.e. underplant longleaf pine	
	Less fire exclusion time due to faster growth	
Natural	Less expensive: no seedling and planting costs	Less productive timber management
	More conducive to conservation-oriented management: uneven-aged	Poorer stand development: form, growth
	Less heavy equipment entry (soil compaction, rare plants)	Less control over seedling quality: only single tree selection thinning (seed trees)
	Lack of rows may increase aesthetics	Less control over seedling density and spacing
	Even-aged pine stands can be converted to two-aged, then uneven-aged structures	Cannot control cone/seed production
	More fire exclusion time due to slower growth (slash, loblolly, shortleaf)	May require single or multiple premerchantable release thinnings (cost)

8.2.2. Site Preparation

Adequate site preparation is required to achieve high survival rates and successfully establish a new stand of timber. The following methods can be used in various forest types for natural or artificial regeneration. Site conditions, landowner objectives and budget drive this selection. Target vegetation includes herbaceous, grasses, non-crop pines, woody shrubs and hardwood species. Site preparation is broken into three categories: chemical, mechanical and prescribed fire. These methods can be used individually or in combination. Site preparation treatments generally take place in the spring and summer months prior to winter planting.

Vegetative competition varies across sites and the appropriate site preparation technique(s) should be selected to adequately control it. Vegetative competition control prior to planting increases the stand establishment success. With adequate site preparation, loblolly and shortleaf pine will initiate fast, early vertical growth. For longleaf pine, adequate site preparation is essential for seedling survival.

8.2.2.1. Chemical Site preparation

The use of herbicides over mechanical treatments in site preparation has increased in the last couple decades for a variety of reasons, including increased machinery and fuel costs, increased chemical specificity, the ability of herbicides to kill the entire root of unwanted hardwoods, and the minimal impact of herbicides on soils (UF IFAS Extension 2009). Herbicide is applied based on the recommended site preparation label rate for the target and crop species and site conditions. The appropriate herbicide and chemical site preparation technique is selected to effectively target the primary woody and herbaceous vegetative competition. Site preparation herbicide is typically applied aerially by helicopter or through ground application using the broadcast or banded techniques. There are site-specific [SC BMPs for Forestry](#) related to site preparation, particularly in wetlands and streamside management zones.

The use of herbicides in chemical site preparation offers some noticeable benefits, but also has noticeable shortcomings. Herbicides can effectively provide longer-lived control of competing vegetation, which leads to an increased economic return for the landowner. Their application does not affect the soil of a site, meaning that soil compaction does not occur and the soil is protected. They can also control exotic or invasive species relatively effectively. However, there are disadvantages as well to choosing chemical site preparation, with chief among them being the cost depending on the brand used. Herbicides may also prevent a problem if used without caution, as surface runoff or spills can have potentially unintended effects on surrounding vegetation.

Each herbicide used has different characteristics that allow it to be used in specific situations and to target specific forms of vegetation. The active ingredient present within the herbicide has the greatest influence on the effectiveness of the herbicide, as it is the portion of the herbicide that negatively affects the desired vegetation (Osiecka et al. 2005). A listing of common active ingredients, along with the species targeted by the herbicide, the species resistant to the herbicide, and the proper application period can be found through the [NC State 2017 Quick Guide to Forestry Herbicides Used for Softwood and Hardwood Site Preparation and Release](#). It is important to consult a professional forester prior to herbicide use in order to ensure correct application and usage.

Chemical site preparation techniques and application methods are varied, depending on the species present and the desired outcome of the chemical application. Herbicide labels give the types of application methods registered for each herbicide. Factors such as tract size, stand density and structure, the needed application rate, and the proper application timing are also essential to determine before selecting the proper herbicide (Osiecka et al. 2005). Below are common techniques for the application of herbicides; also, [Manual Herbicide Application Methods for Managing Vegetation in Appalachian Hardwood Forests](#) provides details concerning the chemical composition of and application methods for various herbicides.

8.2.2.1.1. All Herbicide Types

Broadcast

Broadcast applications involve herbicide being spread out over an entire area. This method of treatment is accomplished either through the air (usually by helicopter or more rarely aircraft) or on the ground through the use of machine-mounted or hand-held equipment. This is the general method utilized for site preparation, but it may also be utilized for conifer release or weed control.

Band

Band applications are similar to broadcast treatments in their general application method but are applied in strips or along rows of planted trees with ground-based equipment. This method is as effective as using broadcast for herbaceous weed control in young pine plantations and may also provide a significant cost decrease if used properly. Annual weeds are usually more effectively controlled by this method compared to perennial weeds.

Spot

Spot applications are applied as needed to smaller areas or even individual stems, typically with hand-held spraying devices to ensure greater accuracy. If the proper species are targeted with this method, the reduction of unwanted species can be obtained at a far cheaper cost. However, these types of treatments are typically very labor intensive and can only be justified as a treatment method within areas containing a small number of problem spots needing treatment.

Directed Spray

Directed spray is a form of spot treatment used primarily for conifer release and occasionally weed control. The spray from hand-held spray units can be effectively directed only to the foliage being targeted while avoiding crop/plantation trees. In addition to spraying, herbicide can be applied through this method by wiping directly onto the target species with a wick applicator.

Basal Bark Spray

The basal bark application method involves spraying intact bark with a particular herbicide. This application type is best utilized with ester formulations with an oil carrier. With basal bark spraying, small stems can be treated by thinline spraying (herbicide applied in a narrow band 6-24 inches above stem base) or full basal (spray-to-wet) spraying (spraying the entire lower 12-20 inches of the plant to the point of runoff). Basal bark spraying can be done throughout the year as long as the bark is dry.

Hack and Squirt

The hack and squirt application method involves cutting or drilling into the sapwood of the tree and immediately applying herbicide to the interior of this cut. This application method is most effectively for treating large-diameter trees and requires the herbicide to be water soluble and not in an ester formulation. Hack and squirt can be done most of the year, but it is less effective before and during the Spring flush.

Injection

The injection method is similar to hack and squirt, except it does not involve cutting into the tree prior to application. Herbicide in this method is injected directly into the tree's interior through use of a special device. The application timing for this method is similar to hack and squirt.

Cut Stump

The cut stump application method involves application of an herbicide to the outer edge of a freshly-cut stump. This method is most effective on woody species that are known to resprout following being cut down.

Grid Application

The grid application method involves using a grid pattern when applying soil-active herbicide to an entire area. The grid pattern selected as well as the rate of herbicide application is dependent on the soils texture and woody species composition of the site. This method can be used for conifer release as well as site preparation, particularly on sites with a high density of unwanted woody vegetation.

Spot-Around

The spot-around application method involves the application of granular soil-active herbicide to an area around the trunks of the trees wanted to be kept. Herbicide application within this method can be in the form of small spots or a small area. This method prevents woody and herbaceous vegetation from overcrowding the target tree species.

Individual Stem

The individual stem (basal soil) application method involves the application of specific herbicides to the soil directly adjacent to the stems of targeted woody species.

8.2.2.2. Mechanical Site preparation

There are many mechanical site preparation methods to choose from. Some can be used on various sites, while others have very site-specific applications. All the following methods can be used with establishing all the pine forest types.

8.2.2.2.1. Bedding

Bedding is used on flat, wet sites to elevate the roots of seedlings and promote respiration and growth. There are various bedding machines that create beds of different heights, depending on is the moisture level of the site. Some wet sites are difficult or impossible to successfully, artificially regenerate without beds. Bedding is appropriate for timber management objectives but can have long-term negative impacts on desirable groundcover, aesthetics and hydrology. Bedding should be oriented so surface water drainage is not blocked. Bedding machines are pulled behind farm tractors, bull dozers, or more commonly, skidding machines, depending on horsepower requirements and site conditions. Bedding is typically done during the driest months of the year, September and October. For more information on bedding, go to: <https://www.ncforests-service.gov/publications/Forestry%20Leaflets/FM06c.pdf>

8.2.2.2.2. Roller drum chopping

Roller drum chopping is used on various pine flatwoods sites to reduce woody and herbaceous competition, but it is mostly used to help facilitate planting access on sites with thick competing cover resulting from 3-5 growing seasons. Chemical site preparation in conjunction with roller drum copping will deliver the best results when compared to roller drum chopping alone. There are various sizes of roller drum choppers with various lengths of blades. The appropriate equipment is selected based on site conditions (i.e. soil moisture, topography, etc.) and vegetation size and density. Many chopping machines can be filled with varying levels of water to achieve different degrees of vegetative impacts. For example, a site with light, herbaceous vegetation may not require the chopper to be filled, while it may be appropriate to chop a heavy gallberry site with a full drum. Choppers are pulled behind farm tractors, bull dozers, or more commonly, skidding machines, depending on horsepower requirements and site conditions. The SCFC rents roller drum choppers

as a fee under landowner services. This fee is based on acres being roller drum chopped and the mileage for delivery. The landowner/contractor is responsible for providing the machinery to pull it.

8.2.2.2.3. Scalping and ripping/subsoiling

Scalping and ripping/subsoiling usually only take place on old field and pasture sites during afforestation. Scalping peels back thick, matted turf grass, creating a vegetation-free strip to plant seedlings in. Ripping or subsoiling is used in compacted soils like those found in pastures and old field sites, particularly those on clay soils.

8.2.2.2.4. Root raking and piling

Root raking and piling, with an optional pile burn is a common site preparation method used to reduce debris for mechanical planting. Usually only large surface material is raked for silvicultural use, not stumps and roots as is the case during land clearing operations. The piles may be left or burned, depending on objectives, budget, and burning regulations. Often in South Carolina pile burns are discouraged due to potential smoke problems, so care and research of burning regulations should be undertaken prior to a pile burn.

8.2.2.2.5. Mowing and mulching

Mowing and mulching can be effective mechanical site preparation in stands to be naturally regenerated, especially those with heavy fuel loads and lack of prescribed fire history. Mowing can reduce the fuel load and allow for safer, more effective site preparation burns.

8.2.2.2.6. Harrowing/disking

Harrowing/disking can be used on relatively clean sites or those that have been raked or burned, to create vegetation-free strips to plant seedlings in.

8.2.2.2.7. Shearing

Shearing involves a heavy bulldozer equipped with an oversized V-blade that shears off stumps and other vegetation and debris. This material is then piled with root rakes and typically burned. This creates a very clean planting site, ideal for establishing a pine straw stand. Shearing is most often used with bedding. If the tractor is large enough, it can shear and bed at the same time, but most often it takes two tractors, one shearing in the front and one bedding in the rear. Shearing can also be used during groundcover restoration; converting clearcut timber to pasture or crops; or shearing strips within thick competing cover to allow planting access.

8.2.2.2.8. Logging

Logging impacts to understory vegetation can be utilized as part of a broader site preparation plan, especially when carefully timed. In heavy fuels and understory, logging acts as an initial fuel reduction treatment that can be followed up by chemical, mechanical and/or prescribed fire site preparation.

8.2.2.2.9. Anchor chain/dragging

Anchor chain/dragging is an efficient way to remove dense stands of trees and shrubs (Boerr et al 1986). This method involves pulling a heavy anchor chain (~7000 lbs.) 100-500 feet between 2 bulldozers in a V-



or-J-shaped loop. Steel bars may be welded to individual chain links in order to increase scarification within the soil. Dragging requires high-power machinery, and is not as effective on young, supple plants. This method is less commonly used in South Carolina

8.2.2.3. Prescribed Site Preparation Burn

Prescribed fire can be used solely or in combination with other site preparation methods. It is becoming less and less common to prescribe site preparation burns following mechanical and chemical site preparation in South Carolina, although in certain circumstances the practice may be helpful. Site preparation burns typically take place in the late summer, early fall, once fuels have cured, and prior to winter planting.

If timber management is not an objective, a winter site preparation burn alone and prior to planting may be adequate to establish a loblolly stand. Survival rates will likely be lower compared to more intensively prepped sites.

8.2.3. Artificial Regeneration

Artificial regeneration generally occurs after clearcutting and site preparation during the following winter months between December and March. If site preparation includes chemicals, it is best not to plant too soon after application. This is especially the case for longleaf which is known to be more sensitive to Imazapyr, the base herbicide in most chemical site preps. Referring to "SCFC's SPB Program's guide to Herbicide Site Prep and Survival..." will help ensure one is not planting too soon after chemical site prep. Planting too soon after bedding or scalping can have negative consequences as well since seedlings are more likely to be buried. Waiting after 2-4 inches of rainfall will allow soil settlement prior to planting. Table 6 provides a summary of the advantages and disadvantages of artificial and natural regeneration.

Artificial regeneration generally involves planting seedlings in rows that are spaced at a desired density. A spacing of 6' X 10' says that the seedlings are 6' apart within 10' rows. However, a random or natural pattern can be established as well using hand planting. High survival rates depend on selecting appropriate species for the site, adequate site preparation, suitable planting method, proper care of quality seedlings and natural factors such as climate and pests. A seedling survival check should be conducted following the first growing season to determine if the stand was successfully established, to document initial stocking and decide if supplemental planting is required to achieve desired stocking. To ensure a manageable stand, a minimum density of 300 trees per acre should be obtained after the first growing season.

Planting density is an important consideration and is dependent on landowner objectives, available markets, budget, site conditions, cost share requirements and other factors. The soil productivity, hydrology and natural community should be accurately evaluated during artificial regeneration planning. A density is selected that meets primary objectives such as timber, wildlife, aesthetics and recreation. If timber management is an objective, a relatively higher density may be selected. Available pulpwood markets should have an effect on density as well. Landowners in good pulpwood markets should consider taking advantage of them by planting at a density that ensures the earliest merchantable first-thinning. Spacings of 6' X 10', 6' X 12' or 7' X 10' are common under this scenario. Other landowners, or landowners with small stands, may want to consider planting fewer trees that postpones the first-thinning, but the trees will likely be more merchantable with larger diameters and more height. Spacings of 8' X 12' or 9' X 10' are common under this scenario.

If timber management is not an objective, lower planting densities may also help meet wildlife, rare plant and aesthetic objectives. However, due to tree biology and physiology, planting at too low of a density will result in aesthetic tradeoffs and a stand of short, shrub-like trees with excessive limbs. They will never develop into tall, straight, well-formed trees as most landowners aesthetically desire and envision in their forest. A medium, balanced density that meets multiple objectives can also be considered.

Successful artificial regeneration with longleaf pine has been historically challenging, especially on wetter sites. However, in recent decades, an increase in research has led to higher quality seedling stock and more effective site preparation and reforestation techniques. This progress has resulted in higher survival rates, increasing seedling demand and the number of nurseries growing quality longleaf seedlings (Brockway et al.2006).

Longleaf is a good alternative to loblolly pine on less productive, sandy soils for landowners interested in managing for multiple uses. The dichotomy between managing loblolly and longleaf on flatwoods sites can be reviewed with the landowner prior to species selection. Flatwoods sites with long-term fire exclusion will be the hardest to get longleaf established and will also require longer suppression of competing shrubs such as inkberry and gallberry. This decision is driven by the typical species selection considerations, but landowner objectives will ultimately determine the appropriate species to plant.

Although the state of South Carolina has no regulation regarding survival standards, attaining 90+% survival rates with pine species can be achieved with careful reforestation planning and execution. Landowners should establish their own standard for survival prior to planting, given the site conditions. Planting a few extra seedlings for “insurance” towards a desired stocking density may also be worthwhile.

8.2.3.1. Hand Planting Vs. Machine Planting

8.2.3.1.1. Hand planting

Hand planting entails crews planting seedlings by hand. Refer to [Table 6](#) for more information on this method and a comparison with machine planting.

8.2.3.1.2. Machine planting

Machine planting involves two main methods (flatwoods planting (rubber-tired tractor) or V-blade planting). Flatwoods planting requires a cleaner site, hence more mechanical site preparation. This is due to limitations of the planting machine itself and the rubber-tired farm tractor commonly used to pull it. V-blade machine planting generally uses the same planting machine, but is pulled behind a bull-dozer with a large heavy duty “V”-shaped blade that clears large debris and creates a vegetation-free strip that seedlings are planted in. V-blade planting can handle rougher sites, and therefore does not require as much mechanical site preparation. V-blade is essentially planting and site preparation in-one, but costs more than flatwoods planting. On wetter sites, V-blade planting can result in planting seedlings in a trench, which can lead to high mortality and poor growth of the surviving seedlings. V-blade planting is particularly useful on large acreages, on acreages where planting access is difficult, or where chemical site preparation methods conflict with landowner objectives. Refer to [Table 7](#) for more information on machine planting. Any of these planting methods can be used to plant pine species.

Table 7 Comparison summary of hand and machine planting methods of artificial regeneration

	Pros	Cons
Hand Planting	Less expensive than machine planting	More potential for human-caused error i.e. J or L rooting, seedling depth and packing issues, etc.
	Can plant rough sites without raking	Inexperienced crews require more supervision
	Experienced, supervised crews have similar quality and consistency to machine planting	
	Less groundcover impact and soil compaction	
	Easier to plant any pattern for natural look (no rows)	
	Can use for under-planting thinned stands	
	Can plant any pine or cypress species; bare root or containerized seedlings	
	Can be used on hills and steep topography	
Machine Planting (Flatwoods & V-Blade)	Less human-caused error i.e. J or L rooting, seedling depth and packing issues	More expensive than hand planting
	Generally, more consistent than hand planting	Flatwoods requires cleaner site/more mechanical site preparation
	Requires less supervision	More groundcover and soil impacts, especially V-blade
	Can plant any pine species, bare root or containerized seedlings	Harder to plant natural pattern
	V-blade requires less site preparation	Cannot under-plant thinned stands
	Ensures straighter rows for easier management	Harder to plant hills and steep topography

8.2.3.2. Under-Planting

Under-planting longleaf pine in heavily thinned slash or loblolly stands can be used as an alternative to clearcutting for species conversion. This method fits stands where aesthetics, wildlife, and rare plants are more desired than timber management. The advantages to this method are better quality post-planting prescribed burns due to retained needlecast and better aesthetics by avoiding clearcuts. Trees with large crowns should be retained for optimal needle-cast. These overstory trees can be removed during the first longleaf thinning or retained for a multi-aged look. The disadvantage is slowed timber growth due to shading, and seedling competition originating from the overstory trees.

8.2.3.3. Seedlings

This section will focus primarily on artificial regeneration methods with pine seedlings. Large-scale artificial reforestation with hardwood species is less common than with pine species throughout South Carolina. Seedling cost and management considerations often lead many landowners to use natural regeneration practices (over artificial regeneration) for large-scale hardwood regeneration efforts. However, hardwood

and cypress seedlings are available in local nursery markets, mainly in containerized form. Pond and bald cypress are available in traditional, “cell” containerized form, while hardwood seedlings generally start in larger 1-3 gallon containers for landscaping markets. Hardwoods are more commonly planted on a smaller-scale, focusing on wildlife management; for example, planting white oaks adjacent to food plots for enhancing hunting programs. Cypress is often planted near pond edges for wildlife or aesthetics and small-scale wetland restoration.

8.2.3.3.1. Containerized Vs. Bare Root

8.2.3.3.1.1 Containerized seedlings

Containerized seedlings are considered higher quality and average higher survival rates but are more expensive. Containerized seedlings are more resilient during transport and storage and can be kept longer once lifted if properly stored in a refrigerated trailer (i.e., refer). Slash, longleaf, and loblolly pine seedlings are available with various genetic *improvements*, such as growth rate, form and disease resistance. Improved, containerized slash pine seedlings are more expensive than bare root and are preferred if planting budget allows. Orders can be placed early summer to ensure needs are met and to avoid delays in planting. The ideal planting window for South Carolina is from December to March.

8.2.3.3.1.2 Bare root seedlings

Bare root seedlings, in comparison, generally average lower survival rates, require immediate planting once lifted, and are very vulnerable during transport and storage, yet are less expensive. Bare root seedlings are very sensitive to warmer temperatures, dry air, and direct sunlight. Bare root can have comparable survival to containerized with proper planting technique (depth, angle and packing), adequate site preparation, storage and handling.

Both seedling types’ survivability increases exponentially if planted as soon as possible after lifting, stored in a refrigerated cooler (i.e., “reefer”), and/or kept under seedling tarps in the shade prior to planting. Hand, flatwoods and V-blade planting methods can be used to plant all the South Carolina pine species, bare root or containerized.

8.2.3.4. Afforestation

South Carolina has a long history of agricultural production such as tobacco, Carolina gold rice, and cotton. These industries have faded and changed in recent decades, resulting in land-use conversions to timber and cattle production. Many landowners plant various pine species on old field and pasture sites within the state.

Many of these sites were heavily fertilized or grazed and still contain high nutrient loads, especially those with heavy clay soils. This causes many pine stands to develop poor form, excessive limbs and forks and a high occurrence of fusiform rust. This effect tends to be localized and more severe on heavy soils and where cattle were fed. Landowners managing their pine for timber products generally are not concerned with these issues. If nutrient loads are not excessive, this can have a positive fertilization-like effect on growth rates and timber production.

Old field and pasture sites will require scalping and/or ripping (subsoiling) prior to beginning the afforestation process as discussed in the [site preparation section](#).

8.2.4. Natural Regeneration

Pine, hardwood and cypress stands can be naturally regenerated to meet various objectives, including uneven-aged management. This section will examine both hardwood and pine natural regeneration site preparation processes, although commercial hardwood management activities are far less common within South Carolina. Large-scale [artificial regeneration](#) of cypress and hardwood is generally not economically feasible for most private landowners. These species can coppice and are generally clearcut and regenerated in this manner. High-graded hardwood and cypress stands (timber capable of producing the most high-value products) can be clearcut and naturally regenerated to improve timber quality and aesthetics. Reference [Table 6](#) for general information on pine natural regeneration and a comparison between this method and artificial regeneration.

[Premerchtable thinning](#) is often required in natural pine regeneration management regimes and is discussed in the [release](#) treatment section.

Existing loblolly pine stands can be naturally regenerated to meet various objectives, including two-aged management and aesthetics. Due to the growth characteristics and product markets, this pine species is not usually managed uneven-aged, although shortleaf and longleaf stands may be. Some natural pine stands encountered may have been historically high-graded and a decision must be made on whether to clearcut and start over by planting higher quality genetics or naturally regenerate and hope for the best.

The different pine species have different annual windows of seed production. Loblolly pine produces seed annually which usually peaks in October. Longleaf seed production usually peaks in October, but only produces bumper crops every 7-10 years, while shortleaf peaks in October as well but produces bumper crops every 3-6 years. Planning for natural regeneration of pine entails evaluating the cone crop the prior Spring and carefully timed site preparation prior to fall. seed catch. Natural regeneration of pine species requires careful planning and coordination.

8.2.4.1. Site preparation

8.2.4.1.1. Pine forest types

Site preparation options are the same between pine natural regeneration methods and are like [artificial regeneration site preparation](#). A natural regeneration harvest itself can serve as a form of site preparation. On sites with a history of prescribed fire or light fuel loads, site preparation may simply entail a carefully timed prescribed burn. Prescribed burning in spring to early summer will prepare the seed bed by scarifying the soil, promoting seed catch. Conducting prescribed burns near seed dispersal should be avoided, as seed predation will be greater due to less groundcover. Some understory regrowth is desirable, so the seeds are not completely exposed to predators. In stands with heavy fuel loads, a single site preparation burn will likely not be adequate. Establishing a [fire regime](#) and reducing fuel loads over time can allow for a successful site preparation burn in the future, or a combination of site preparation methods can be used with prescribed fire to achieve natural regeneration sooner.

Seed trees should be considered and protected as needed when conducting site preparation activities for natural regeneration.



8.2.4.1.2 Hardwood forest types

For Pine/Hardwood Mixed and Upland Hardwood forest types, timing of site preparation activities such as a prescribed burn has an effect on the overall survival of natural recruitment. Different forms of site preparation are recommended for hardwood forests, such as a natural regeneration harvest or clearcut. A carefully timed natural regeneration harvest typically serves as site preparation when attempting to naturally regenerate hardwood stands, while coppice can also be utilized to reforest a clearcut. Research has shown that fire applied at the beginning of an Upland Hardwood rotation can increase more valuable shade-intolerant species such as oaks. Other forms of site preparation previously discussed may also be utilized.

The Bottomland Hardwoods forest type can be naturally regenerated to meet various objectives, including uneven-aged timber management, timber stand improvement, wildlife and aesthetics. Mixed bottomland hardwood species can **coppice** and are generally clearcut and regenerated in this manner. High-graded mixed bottomlands can be clearcut and naturally regenerated to essentially start over by improving timber quality and aesthetics.

Thinning from above, shelterwood, seed tree and group selection natural regeneration harvests may also be utilized in mixed bottomlands but this is less common in South Carolina.

8.2.4.2. Shelterwood

Shelterwood is generally the most effective method of natural regeneration across South Carolina pine species. This entails thinning a stand to approximately 30-40 square feet per acre of basal area or about 20-50 trees per acre. Shelterwood allows for a more uniform coverage of natural regeneration across a stand. It also allows for a uniform application of prescribed fire across the site by maintaining adequate needlecast. Younger age classes are sheltered by a higher density of seed trees. Seed trees should be the highest quality in terms of crown size, form and health/vigor. Seedling growth may be slightly lower compared to seed tree method if seed trees are retained, which is optional, following successful stand establishment.

This strategy may also be utilized within Pine/Hardwood Mixed and Upland Hardwood forest types.

8.2.4.3. Seed Tree

The seed tree method is used throughout the varied pine and hardwood forest types. The seed tree method is like shelterwood except stands are thinned to a slightly lower basal area of approximately 10-30 square feet per acre or about 10-20 trees per acre. A good cone crop is important using this method to ensure adequate seed catch at this lower density. Seed trees should be the highest quality in terms of crown size, form and health/vigor. Seedling growth may be slightly higher compared to shelterwood if seed trees are retained, which is optional following successful stand establishment.

8.2.4.4. Group Selection

The final method of natural regeneration is group selection, which is less commonly used to naturally regenerate pine and upland hardwood forest types. These are small 0.25 - 0.5-acre clearcuts interspersed throughout a stand. The size is critical to ensure adequate seed coverage. If they are too large, the interior portions may not regenerate adequately. Consequently, these understocked areas tend not to burn

consistently due to lack of needlecast, leading to thickets of woody vegetation. Group selections can be conducted independently, but more commonly made in combination with a stand-wide thinning. Group selections can be beneficial to wildlife since they create edge and a juxtaposition of habitat.

8.2.4.5. Thinning from Above

This method of thinning can be used to release existing natural regeneration in Pine/Hardwood Mixed and Upland Hardwood forest types. This entails removing all or part of the dominant overstory trees, releasing the suppressed natural regeneration already in place within the midstory. This requires carefully planned logging operations so as to not destroy the desired trees being released during overstory harvest.

8.3. Release

Early and mid-rotation release treatments are common in pine management and less common in Pine/Hardwood Mixed forest types within South Carolina. Chemical, mechanical, prescribed fire, and premerchtable thinnings are the three primary types of treatments used to release pines from vegetative competition and promote timber production through increased vertical and diameter growth and good form. For Pine-Hardwood Mixed, only chemical and mechanical treatment types are utilized, as prescribed fire is not a viable tool within these forests. Target vegetation includes herbaceous, grasses, non-crop pines, woody shrubs and hardwood species. These treatments may take place in planted or natural pine stands. Merchantable thinning harvest is another form of release and discussed in the timber harvest section.

8.3.1. Chemical

Early and mid-rotation herbicide release treatments targeting vegetative competition are utilized where additional competition control is required. This is sometimes due to insufficient site preparation. Herbicide is applied based on the recommended release label rate for the target and crop species and site conditions. The appropriate herbicide and chemical release method are selected to effectively target the primary herbaceous and woody vegetative competition.

These early and mid-rotation methods include:

- Ground
 - Broadcast or banded
 - Skidder, farm tractor or All-terrain vehicle ATV-mounted sprayers
 - Spot (grid)
 - ATV or backpack sprayers
- Aerial
 - Broadcast
 - Helicopter

8.3.1.1. Herbaceous Weed Control

Herbaceous weed control is mostly utilized in recently planted pine forests that were site prepped using the bedding or V-blading technique. In the spring just after planting, herbicides are applied over the top using

the band spray technique, which is the name it is also referred to as. Proper herbicides, rates and timing suppresses herbaceous weed growth, while increasing pine growth and survival.

8.3.1.2. Woody Stems/Understory

Understory trees, woody brush, and herbaceous weeds may also be suppressed using a chemical herbicide application and treatment. This treatment type is usually completed in pine forests after the first thinning using a skidder, but can involve spot treatment techniques when competition is less intense.

8.3.2. Mechanical

Early and mid-rotation mechanical release treatments targeting vegetative competition are utilized where additional competition control is required. This is sometimes due to insufficient site preparation. These treatments are like [site preparation](#) and include: mowing, chopping, mulching, and the utilization of hand tools. All four can be used for early-rotation release but caution should be used to avoid damaging young pines. Chopping may damage feeder roots in mature pines and should be avoided mid-rotation.

8.3.3. Prescribed Fire

[Prescribed fire](#) can be used as an early rotation release in shortleaf pine stands after year two, since they readily resprout after fire. Prescribed fire is an effective competitive management tool in longleaf stands beginning at year two. Broadcast prescribed burning serves as a mid-rotation release in loblolly stands.

8.3.4. Premerchantable Thinning

Pre-merchantable thinnings are common in overstocked, naturally-regenerated pine stands. These treatments reduce competition and promote proper stand development. They can also be used to improve aesthetics, wildlife habitat, and forest health. Pre-merchantable thinning is a cost, but the SCFC's SPB Program offers cost-share assistance for this practice. If there is enough material per acre, a fuelwood chipping operation can substitute and generate revenue or break-even. Merchantable thinning is a release treatment in older stands and discussed in the timber harvest section.

8.4. Prescribed Fire

Pine forest types

South Carolina's natural communities were shaped for centuries through fires started by lightning, Native Americans and settlers. Early European settlers documented vast, open, park-like [longleaf pine](#) forests maintained with fire. Prescribed fire is a key land management tool used to maintain and restore the fire dependent natural communities of South Carolina by mimicking historical, natural fire regimes and resetting succession. Prescribed fire is safely and responsibly applied to ecosystems to achieve various land management objectives such as aesthetics, wildlife habitat and biodiversity.

Prescribed fire plays a critical ecological maintenance and restoration role in pine forests, mimicking historic natural fires. Without fire, pine forests would succeed to hardwood forests in most cases.

Shortleaf and loblolly pine are fire tolerant once the bark thickens and they reach about 10-15 feet tall (depending on fuel load). Longleaf is the most fire tolerant species of all the southern pines; it can withstand

fire once it is approximately one full year-old following planting. Once longleaf reaches three to five feet in height, fire-caused mortality increases. Above six feet, longleaf is more tolerant of fire. Longleaf, loblolly, and shortleaf pine should all be burned every one-to-three years to maintain and restore the natural communities in which it is dominant and to enhance wildlife habitat, improve aesthetics, reduce vegetative competition, reduce fuel loads and stimulate rare plants.

Hardwood forest types

Aside from the previously discussed upland pine natural community ([longleaf](#), [loblolly](#) and [shortleaf](#) pines), pine/hardwood mixed forests are not fire dependent and rarely burn. However, their ecotones generally burn along with their adjacent fire dependent uplands. Burning these ecotones is crucial for the many rare species found there. Mixed forests with an adequate pine component will carry fire. Pure hardwood stands only entirely burn within narrow fire weather conditions.

Research, however, has shown that certain hardwood types, particularly oak-dominated communities as seen in the Piedmont of South Carolina, can benefit from prescribed burning although they are not necessarily fire-dependent (Van Lear et al. 1999). As fire was gradually removed from oak-dominated and other upland hardwood communities, shade-tolerant species began to dominate the understory and then the overstory as disturbance allowed them access to sunlight. On better quality sites, frequent burning has been seen to create oak-favorable environments by removing shade-tolerant understory species. This creates a bare forest floor that promotes oak regeneration through squirrel and blue jay acorn burying and also reduces soil moisture, keeping oaks at an advantage over mesophytic shade-tolerant species such as birch, maple, or hickory.

Certain factors must be considered when burning in oak-dominated Upland Hardwood forests. Oaks can tolerate high-intensity burns than shade-tolerant species due to their sprouts originating deeper in the soil and greater energy for sprouting stored in their roots (Brose and Van Lear 1998); therefore, a high-intensity burn at the beginning of a stand's origination will help to favor oak regeneration. Oaks have the greatest amount of energy storage in the roots during the dormant season, making this a favorable time to conduct burns to promote oaks.

As prescribed burning within hardwood forests is dependent on a variety of factors, it is essential to consult a resource professional prior to attempting a burn. This consultation can provide further information on how and when the burn will be the most effective for a specific purpose.

Bottomland Hardwoods forest types are not fire dependent and burn infrequently, with cypress dominated ponds slightly more frequent than gum-dominated. However, their ecotones generally burn along with the fire dependent uplands they are embedded within. Burning these ecotones is crucial for the many rare species found there. The interior portions of the BH forests generally contain thick duff and muck layers, which rarely burn. If it is an objective to reduce the understory or midstory of one of these ponds with fire, the soil needs to be moist as to avoid a peat fire. Peat fires can burn for months during droughts and cause serious smoke management and safety issues

8.4.1. Advantages of Prescribed Fire

There are many benefits to using prescribed fire to meet land management objectives. This practice reduces fuel loads, which directly lowers the risks and hazards associated with catastrophic wildfires. If a wildfire occurs in an area with a history of prescribed fire, the intensity and severity of that wildfire will be substantially less compared to areas without.

Prescribed fire opens the mid and understories by consuming overgrown vegetation and dead fuels. This stimulates many species of grasses, forbs and herbs. The result is an open, lush, scenic understory that is aesthetically pleasing. Stands maintained with prescribed fire have more plant and wildlife biodiversity compared to fire suppressed stands. Even old field sites planted with pines develop a more diverse understory compared to those without fire. This diverse, open understory is also beneficial to many species of wildlife, including several rare species such as the red cockaded woodpecker, which requires this fire-maintained structure. Likewise, allowing fire to burn through isolated and ephemeral wetlands within forest stands is beneficial for diversity in those natural communities.

Prescribed fire increases the nutrient content of forage species and the mast productivity of species such as blueberry (*Vaccinium* spp.). Wildlife prefer this nutrient and mast-rich understory. Pines and other plant species receive a post-burn flush of nutrients through increased nutrient cycling.

Landowners also enjoy this fire-maintained understory for the improved access and beautiful, open views it provides. This enhances recreational activities such as hunting, wildlife viewing and hiking. Prescribed fire also reduces many forest pests. This also improves outdoor recreational experiences and helps reduce the spread of tick-borne illnesses such as Lyme disease and rocky mountain spotted fever.

8.4.2. Disadvantages of Prescribed Fire and Ways to Mitigate

Inappropriately applied prescribed fire can reduce growth rates and lead to mortality in pine stands. Excessive heat can scorch crowns and cause damage to feeder roots and inner bark. Excessive scorch alone may just slow growth and cause isolated mortality. When excessive scorch is combined with other stress factors such as poor soil quality, offsite species, overstocking and drought, widespread mortality may occur (FDACS 2012-2019). Southern pine beetle (*Dendroctonus frontalis*), ips beetle (*Ips* spp.), or black turpentine beetle (*Dendroctonus terebans*) outbreaks are more likely to occur following excessive scorch.

There are ways to mitigate these negative impacts. Cool, dormant season burns can be utilized initially until fuel loads are reduced, especially in long-unburned stands. Thick duff layers can be reduced slowly over time by only burning following precipitation to avoid damaging feeder roots. Appropriate firing techniques should be selected considering overstory species, stand structure, burn objectives, desired fire intensity and severity, fuels (type, loading, structure) and weather conditions.

Fire is inherently dangerous, so a certain level of risk comes along with conducting prescribed burns. Tied to that risk is the liability if a burn does not go as planned which causes many landowners to avoid prescribed burning. Landowners have the option to transfer that liability by hiring a state or private contractor to conduct their burning. South Carolina has strong prescribed fire statutes which protect safe, responsible prescribed burn managers (South Carolina Prescribed Fire Act 1994/2012). Much of prescribed burning revolves

around the weather and even with careful planning and forecasting, the weather can change. Most other preparation and implementation factors can be controlled. Burn planning is crucial and may include:

- Thorough burn prescription development
- Weather forecasting and observations
- Smoke management and screening
- Gathering resources
- Notification of neighbors, the public and local emergency responders
- Having a contingency plan in place

Documentation and record keeping of prescribed fire planning and activities is encouraged.

8.4.3. Methods of Prescribed Fire

8.4.3.1. Broadcast Burning

The act of burning acreage to meet various objectives is referred to as broadcast burning. Broadcast burning includes burning uplands or wetlands. It is the most common type of prescribed fire. Broadcast burning is used to meet various objectives including: fuel reduction, ecological maintenance and restoration, wildlife habitat management, aesthetics and imperiled species management.

8.4.3.2. Site Preparation Burns

Site preparation burning is a form of broadcast burning that prepares sites for artificial or natural regeneration. Site preparation burns reduce vegetative competition, improve access and operability for planting and scarify the soil for seed catch. They also meet some of the same objectives as broadcast burning.

8.4.3.3. Pile Burns

Pile burning is a form of site preparation burning. Large post-harvest debris within clearcuts are raked into scattered piles and burned. The objective is reducing logging slash to improve access and operability for machine planting. Pile burning is not used to reduce vegetative competition. A site preparation burn may incorporate pile burning. When pile burning it is essential to manage the smoke production adequately in order to prevent adverse smoke effects.

8.4.4. Fire Return Intervals

Fire return interval is the frequency at which a burn unit will be burned. This is site-specific and primarily dependent on landowner objectives, budget, forest type, fuel conditions and fire history. Determining the appropriate fire return interval at the burn unit level is vital to a successful burn program.

Loblolly, shortleaf, and longleaf pine should all have prescribed fire every-one-to-three years. This can be adjusted based on the factors listed in the previous paragraph.

8.4.5. Seasonality

Seasonality plays an important role in a prescribed fire program and should be carefully considered to help meet specific objectives. Seasonality should be varied over time, avoiding burning the same stands, during the same season.

Historically, in South Carolina, most natural fires were caused by lightning and occurred mainly during the early growing season (March-May) when storms, high winds, and low relative humidity were the most common. Many plant species adapted to this seasonality and require fire in the spring or summer months to reproduce. For example, wiregrass produces optimal seed when burned in the Spring. Growing season prescribed fire promotes a higher density of grasses, forbs and herbs and lower density of woody species such as inkberry (*Ilex glabra*), gallberry (*Ilex coriacea*), and hardwoods. Growing season burns also reduce fuel loads quicker and result in delayed woody regrowth. If wildlife management is the focus, growing season burns often result in excellent habitat. If isolated wetlands such as cypress ponds or depression marshes need woody species reduction, a Spring burn would be ideal.

However, growing season burns are challenging due to increased potential for scorch caused by higher ambient temperatures. Growing season prescribed burns are ideal for sites with lighter fuel loads or those with a history of prescribed fire. Additionally, not all historic fires occurred during the growing season. The southern pine beetle's main dispersal is in the Spring when trees are already drought stressed. Adding additional stress caused by a hot prescribed burn may lead to an outbreak. Pines are also susceptible to mortality caused by crown scorch during Spring due to bud elongation.

Dormant season burns generally occur between December and February, as the name implies, which promotes more woody species stems per acre and less grass, forb and herbaceous ground cover. However, more legumes respond to dormant season fires than growing season fires. Dormant season burns safely and slowly lighten fuel loads, but post-burn woody regrowth occurs faster, since they have the whole growing season to recover. Dormant season burns are generally easier to conduct due to cooler temperatures, less intense fire behavior, consistent winds and higher fuel and soil moisture. Pine trees are in dormancy during the winter months so impacts from scorch are not as dramatic but should still be kept to a minimum. There are generally more available burn days in dormant season. There is less potential for dormant season burns to stress pines or lead to mortality issues.

Dormant season burns are ideal for sites with heavier fuel loads or those little to no burn history. For example, reintroducing fire to a dense pine plantation with a thirty-year rough (i.e. time since the last burn) would be most successful using a dormant season burn. If desired, burning can be transitioned to the growing season after one to two initial dormant burns. If wildlife management, groundcover and biodiversity are not objectives, but timber management is, dormant season prescribed fire is a better fit. A dormant season burn can substitute for a scheduled growing season burn if winter conditions are more favorable, avoiding missing an entire year.

Young, developing longleaf pine stands are typically burned during this season before terminal bud elongation. A general rule of thumb is burn to using the Dot Fire technique within these weather conditions: RH 35-70%, Temps 45-65F, and winds 5-10MPH. These conditions are usually found in the morning hours

before 2:00PM. The dot fire technique involves placing a backfire on the downwind side before placing dots (spots) of fire upwind on a 2 chain X 2 chain grid.

Fall burns are typically not conducted under pines since they are transitioning into dormancy and very susceptible to mortality during this time. If excessive scorch occurs, pines may not have adequate needles to survive until spring. Fall tends to be the driest time of year in South Carolina (spring being second driest) and there is a fall southern pine beetle dispersal, so adding another stressor is risky. If maintaining quality groundcover is an objective, fall burns are generally avoided since many grasses and herbaceous species flower and seed in the fall. However, if pine dormancy has begun early, the fuel load is light and appropriate lighting techniques are used, it is possible to successfully conduct a Fall burn. This may be beneficial where hardwood reduction is an objective as they are also vulnerable in the fall. Burning in the fall also allows an early start to long burn seasons with ambitious acreage goals.

8.4.6. Fire Weather

One of the most important considerations in planning and conducting a prescribed burn is fire weather. Burn prescriptions contain a section with desired, forecasted and actual fire weather for a burn unit. The United States Forest Service's (USFS) "[A Guide for Prescribed Fire in Southern Forests](#)" is an excellent resource for burn managers in the region and contains recommendations and detailed descriptions of the following fire weather factors (Wade and Lunsford 1989).

Relative humidity (RH) is the amount of moisture in the air in relation to the air temperature. RH is the main factor affecting spotting potential and also affects fire intensity and fuel availability. Various fuel sizes are affected differently by RH. Fine fuels like grasses and leaves are more responsive to RH. They absorb and release moisture much faster compared to the slower responses of heavier fuels like branches and logs. Relative humidity is a factor in whether a fuel will burn and how well it will burn. This is important within the burn unit, but also when using natural firebreaks such as hardwoods. Temperature is a major factor in RH, fire intensity, scorch potential, and live fuel moisture. Wind speed and direction affects fire intensity, rate of spread, smoke management and spotting potential. Dispersion index is essentially a measure of atmospheric stability which is directly related to smoke and heat lift. It also affects scorch potential. Live fuel moisture is a measure of the amount of moisture in live vegetation. This affects fuel volatility, availability and fire intensity. Days since last rain affects live fuel moisture, fire intensity, drought indices, and the ability of natural firebreaks such as hardwood stands or wetlands to hold fire. The Keetch-Byram Drought Index (KBDI) is an indicator of drought severity and may help determine if a prescribed burn can take place. It measures soil and duff layer moisture assuming there are eight inches of moisture available to vegetation in a saturated soil. During burn planning, KBDI can help indicate how wet duff layers and wetlands might be.

8.4.7. Prescribed Burning Regulations

Prescribed burning in South Carolina must be carried out according to the state rules and regulations. In the SC Code of Laws, [Section 48-35-10](#), known as the Notification Law, requires persons doing outdoor burning to (1) notify the SC Forestry Commission, (2) clear around the area to be burned and have adequate personnel and equipment to keep the fire contained, and (3) stay with the fire until it is safe to leave. Go to <https://www.scstatehouse.gov/> for the complete wording of this law.

Title 48, Chapter 34, known as the [South Carolina Prescribed Fire Act](#), provides limited liability protection for persons who have been certified as Prescribed Fire Managers. To become a [Certified Prescribed Fire Manager](#), an individual must successfully complete a training program which includes home study, an 8-hour classroom session, and a written exam. The course is geared toward persons with considerable fire management experience. They must also provide documentation of practical experience in prescribed burning. In addition, they must agree to conduct all burning in compliance with all applicable laws and ordinances.

A complete list of forestry burn regulations for the state of South Carolina can be found in the [South Carolina Forest Law Handbook](#), which can be obtained by contacting the headquarters of the SC Forestry Commission at 803-896-8800.

8.4.8. Prescribed Fire Assistance

The South Carolina Forestry Commission provides several [services](#) related to prescribed burning for a fee. Agency personnel plow firebreaks, provide standby assistance for landowners conducting a burn who follow an approved burning plan, and also provide turnkey prescribed burning. Several private [consulting foresters](#) also offer prescribed burning as a service.

Financial assistance to help cover the costs associated with prescribed burning is sometimes available through the Environmental Quality Incentives Program (EQIP). Contact your local [NRCS office](#) to apply for these funds.

There are also federal wildfire prevention funds (Stevens Funds) that may be available to help pay for prescribed burning on private forestland that is within 10 miles of a National Forest boundary. Check with the [SC Forestry Commission forester](#) in your area to see if you are eligible for this assistance.

To learn more about how to conduct a prescribed burn, landowners can contact their local [SC Forestry Commission forester](#) about possible “Learn to Burn” workshops in their area.

8.5. Fertilization

Fertilization can be utilized on nutrient poor soils in South Carolina. Loblolly pine on flatwoods sites responds to fertilization. Fertilization uptake is dependent on soil composition (i.e. sand versus clay, drainage) among other factors. Bedding on some poorly-drained flatwood sites will sometimes make more nutrients available, reducing the need to fertilize. Excessive fertilization may cause fusiform rust issues and trees to retain limbs longer, both contributing to the degradation of their form. Fertilizer label rates, material safety data sheets and (Moorehead 1998) provide additional guidance on application procedures and rates.

9

Acronymic Key

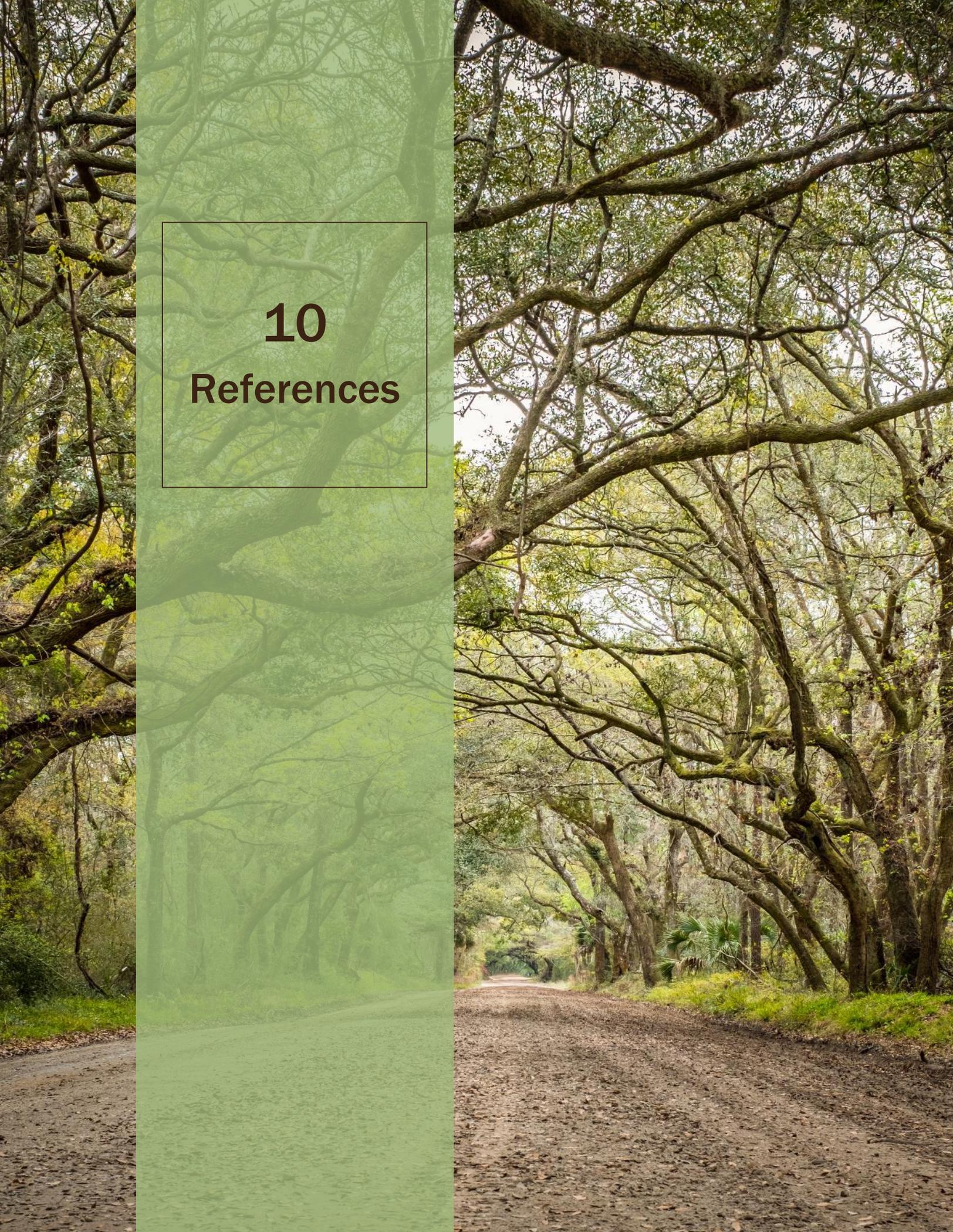




9. ACRONYMIC KEY

Abbreviation	Name
004 Form	ATFS Inspection Form
ACF	Association of Consulting Foresters
AFF Standards	AFF Standards of Sustainability
ALRI	America's Longleaf Restoration Initiative
ATFS	American Tree Farm System
ATV	All-Terrain Vehicle
BH	Bottomland Hardwoods
BMP	Best Management Practice
BR	Blue Ridge ecoregion
BTB	Black Turpentine Beetle
CCAA	Candidate Conservation Agreement with Assurances
CI	Conservation Initiative
CRP	Conservation Reserve Program
CWCS	South Carolina Comprehensive Wildlife Conservation Strategy
EAB	Emerald Ash Borer
ECOS	Environmental Conservation Online System
EIN	Employee Identification Number
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESA	Endangered Species Act
FHTET	Forest Health Technology and Enterprise Team
FMV	Fair Market Value
FORI	Forests of Recognized Importance
FRP	Forest Renewal Program
FSA	Farm Service Agency
FSP	Forest Stewardship Program
FSP Standards	FSP National Guidelines and Standards
GIS	Geographic Information System
GPS	Global Positioning System
HUC	Hydrologic Unit Code
IOBC	International Organization for Biological Control
IPM	Integrated Pest Management
KBDI	Keetch-Byram Drought Index
LLC	Limited Liability Company
LLPI	Longleaf Pine Initiative
LMP	Landscape Management Plan
MACP	Middle Atlantic Coastal Plain ecoregion
MBF	Thousand Board Feet of Timber
NBCI	National Bobwhite Conservation Initiative
NCREIF	National Council of Real Estate Investment Fiduciaries
NIPF	Non-Industrial Private Forest
NNIA	Non-Native Invasive Animal
NNIP	Non-Native Invasive Plant
NNIS	Non-Native Invasive Species
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places

Abbreviation	Name
NTFP	Non-Timber Forest Product
NWF	National Wildlife Federation
NWOS	National Woodland Owner Survey
NWQI	National Water Quality Initiative
OHV	Off-Highway Vehicle
OSB	Oriented Strand Board
PEFC	<u>Programme for the Endorsement of Forest Certification</u>
QTP	Qualified Timber Property
RCW	Red-cockaded Woodpecker
REPI	Readiness and Environmental Protection Integration
RH	Relative Humidity
SAF	Society of American Foresters
SCDA	South Carolina Department of Agriculture
SCDAH	South Carolina Department of Archives and History
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SC-EPPC	South Carolina Exotic Pest Plant Council
SCFC	South Carolina Forestry Commission
SCFRP	South Carolina Forest Renewal Program
SCP	Southern Coastal Plain ecoregion
SCWF	South Carolina Wildlife Federation
SER	Society of Ecological Restoration
SFC	Southern Forestry Consultants
Silviculture BMPs	South Carolina Forestry Commission Best Management Practices for Silviculture
SMZ	Streamside Management Zone
SP	Southeastern Plains ecoregion
SPB	Southern Pine Beetle
SPI	Shortleaf Pine Initiative
Support Committee	Landscape Management Plan Development Support Committee
T&E	Threatened and Endangered Species
UH	Upland Hardwoods
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WBD	Water Boundary Dataset
WLFw	Working Lands for Wildlife
WUI	Wildland Urban Interface



10
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